NEW ZEALAND

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NZS 4541 (2007) (English): Automatic fire sprinkler systems [By Authority of New Zealand Fire Safety and Evacuation of Buildings Regulations 2006 (SR 2006/123)]

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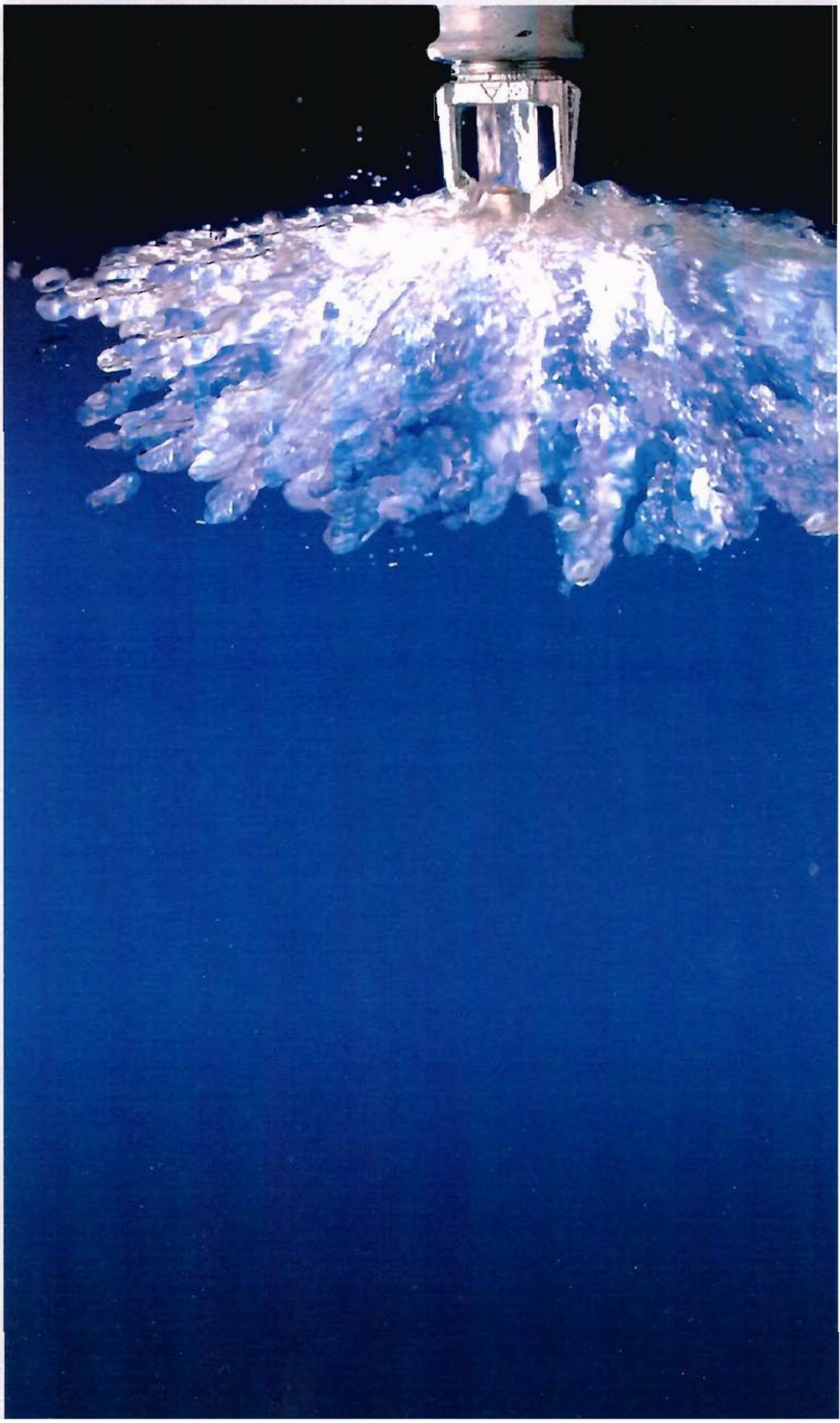
NZS 4541:2007
Incorporating Amendment No. 1

New Zealand Standard

Automatic Fire Sprinkler Systems

STANDARDS
NEW ZEALAND
PAEREWA AOTEAROA

NZS 4541:2007



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New Zealand Standard

Automatic Fire Sprinkler Systems

(Superseding NZS 4541:2003)

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This Standard was prepared under the supervision of the Automatic Fire Sprinkler Systems Committee (P 4541) for the Standards Council established under the Standards Act 1988.

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Referenced Documents

Reference is made in this document to the following:

NEW ZEALAND STANDARDS

NZS 1170: - - - -	Structural design actions
Part 5:2005	Earthquake actions – New Zealand
NZS 1900.5:1988	Model building bylaw – Fire resisting construction and means of egress (Withdrawn)
NZS/AS 2033:1980	Installation of polyethylene pipe systems
NZS 3106:1986	Code of practice for concrete structures for the storage of liquids
NZS 3404:1997	Steel structures Standard
NZS 3501:1976	Copper tubes for water, gas, and sanitation
NZS 3603:1993	Timber structures
A1 NZS 4219:2009	Seismic performance of engineering systems in buildings
NZS 4442:1988	Welded steel pipes and fittings for water, sewage and medium pressure gas
NZS 4503:2005	The distribution, installation and maintenance of hand operated fire fighting equipment for use in buildings
NZS 4510:1998	Fire hydrant systems for buildings
NZS 4512:2003	Fire detection and alarm systems in buildings
NZS 4515:2003	Fire sprinkler systems for residential occupancies
NZS 4541:1972P	Automatic fire sprinkler systems (Withdrawn)
NZS 4541:1987	Automatic fire sprinkler systems (Withdrawn)
NZS 4541:1996	Automatic fire sprinkler systems (Withdrawn)
NZS 4541:2003	Automatic fire sprinkler systems
NZS 4711:1984	Qualification tests for metal-arc welders
NZS 4781:1973	Code of practice for safety in welding and cutting
NZS 5807:1980	Industrial identification by colour, wording or other coding
NZS 7702:1989	Colours for identification, coding and special purposes
SNZ PAS 4505:2007	Specification for firefighting waterway equipment
SNZ PAS 4509:2003	New Zealand Fire Service fire fighting water supplies code of practice

JOINT AUSTRALIAN/NEW ZEALAND STANDARDS

AS/NZS 1170 set	Structural design actions
Part 0:2002	General principles
Part 1:2002	Permanent, imposed and other actions
Part 2:2002	Wind actions
Part 3:2003	Snow and ice actions
AS/NZS 1221:1997	Fire hose reels
AS/NZS 1477:2006	PVC pipes and fittings for pressure applications
AS/NZS 1530: - - - -	Methods for fire tests on building materials, components and structures
Part 3:1999	Simultaneous determination of ignitability, flame propagation, heat release and smoke release
AS/NZS 1905:- - - -	Components for the protection of openings in fire-resistant walls
Part 1:1997	Fire resistant doorsets
AS/NZS 2032:2006	Installation of PVC pipe systems
AS/NZS 2566:- - - -	Buried flexible pipelines
Part 1:1998	Structural design
AS/NZS 2642:- - - -	Polybutylene pipe systems
Part 1:2007	Polybutylene (PB) pipe extrusion compounds
Part 2:1994	Polybutylene (PB) pipe for hot and cold water applications

Part 3:1994	Mechanical jointing fittings for use with polybutylene pipes for hot and cold water applications
AS/NZS 3000:2007	Electrical Installations (known as the Australian/New Zealand wiring rules)
AS/NZS 4130:2003	Polyethylene (PE) pipes for pressure applications
AS/NZS 4765:2007	Modified PVC (PVC-M) pipes for pressure applications
AS/NZS 4766:2006	Polyethylene storage tanks for water and chemicals
AS/NZS ISO 9000:2006	Quality management systems – Fundamentals and vocabulary
AS/NZS ISO/IEC 17020: 2000	General criteria for the operation of various types of bodies performing inspection

INTERNATIONAL STANDARDS

IEC 60947:- - - -	Low voltage switchgear and control gear
Part 4:2002	Contactors and motor-starters
ISO 6182 - - - -	Fire protection – Automatic sprinkler systems
Part 1:2004	Requirements and test methods for sprinklers
Part 7:2004	Requirements and test methods for early suppression fast response (ESFR) sprinklers
ISO 9705:1993	Fire tests – Full-scale room test for surface products
ISO/IEC Guide 62:1996	General requirements for bodies operating assessment and certification/ registration of quality systems

AMERICAN STANDARDS

ANSI/NFPA 13-2002	Installation of sprinkler systems
ANSI/NFPA 13D-2002	Installation of sprinkler systems in one- and two-family dwellings and manufactured homes
ANSI/NFPA 13R-2002	Installation of sprinkler systems in residential occupancies up to and including four stories in height
ANSI/NFPA 15-1990	Water spray fixed systems for fire protection
ANSI/NFPA 16-2003	Deluge foam-water sprinkler and foamwater spray systems
ANSI/NFPA 22-1993	Water tanks for private fire protection
ANSI/NFPA 25-2005	Inspection, testing and maintenance of water-based fire protection systems
ANSI/NFPA 30-1993	Flammable and combustible liquids code
ANSI/NFPA 409-2004	Aircraft hangars
ANSI/NFPA 750-2003	Water mist fire protection systems
ASTM A53-2007	Standard specification for pipe, steel, black and hot-dipped, zinc-coated, welded and seamless
ASTM A135-2006	Specification for electric-resistance-welded steel pipe
ASTM A312-92	Specification for seamless and welded austenitic stainless steel pipe
ASTM A403-93	Specification for wrought austenitic stainless steel piping fittings
ASTM D482-03	Standard test method for ash from petroleum products
ASTM D751-00	Standard test methods for coated fabrics
ASTM D1183-96	Standard test methods for resistance of adhesives to cyclic laboratory aging conditions
ASTM D2261-96(2002)	Standard test method for tearing strength of fabrics by the tongue (single rip) procedure (constant-rate-of-extension tensile testing machine)
ASTM E84-06	Standard test method for surface burning characteristics of building materials
ASTM E711-87(2004)	Standard test method for gross calorific value of refuse-derived fuel by the bomb calorimeter

ASTM F439-06	Standard specification for chlorinated poly (vinyl chloride) (CPVC) plastic pipe fittings, schedule 80
ASTM F442/F442M-99 (2005)	Standard specification for chlorinated poly (vinyl chloride) (CPVC) plastic pipe, (SDR-PR)

AUSTRALIAN STANDARDS

AS 1074:1989	Steel tubes and tubulars for ordinary service
AS 1851:2005	Maintenance of fire protection systems and equipment
AS 2149:2003	Starter batteries – Lead-acid
AS 2417:2001	Rotodynamic pumps – Hydraulic performance acceptance tests – Grades 1 and 2
AS 2845: - - - -	Water supply – Backflow prevention devices
Part 3:1993	Field testing and maintenance
AS 4041:2006	Pressure piping
AS 4118: - - - -	Fire sprinkler systems
Part 2.1:1995	Piping – General
AS 4441 (Int):2003	Oriented PVC (OPVC) pipes for pressure applications
AS 4587:1999	Water mist fire protection systems – System design, installation and commissioning

BRITISH STANDARDS

BS 1387:1985	Steel tubes and tubulars suitable for screwing to BS 21 pipe threads
BS 1780:1985	Bourdon tube pressure and vacuum gauges
BS 2971:1991	Specification for class II arc welding of carbon steel pipework for carrying fluids
BS 3600:1997	Specificatin for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes
BS 5252:1976	Framework for colour coordination for building purposes
BS 5514: - - - -	Reciprocating internal combustion engines: performance
Part 1:1996	Standard reference conditions, declarations of power, fuel and lubricating oil consumptions and test methods (ISO 3046/1:1995)

GERMAN STANDARD

DIN 16005:1987	General purpose pressure gauges with elastic pressure-responsive elements; requirements and testing

MILITARY STANDARDS

MIL-C-8068B:2000	Cloth, coated, nylon, rubber-coated fuel-resistant
MIL-T-6396E:2006	Tanks, aircraft propulsion fluid system, internal removable, non-self-sealing

OTHER PUBLICATIONS

API SPEC 5L:2007	Specification for pipe line
FED-STD 191A-5872:1978	Temperature, high; Effect on cloth blocking
FED-STD 601-8311:1955	Adhesion, seams (Seam strength)
FM Approval Standard 4880:2005	Class 1 fire rating of insulated wall or wall and roof/ceiling panels, interior finish materials or coatings, and exterior wall systems
FM Global Data Sheet 1-57	Plastic building materials in construction, 2005 Edition

FM Global Data Sheet 2-2	Installation rules for suppression mode automatic sprinklers, 2002 Edition
FM Global Data Sheet 2-7	Installation rules for sprinkler systems using control mode specific application (CMSA) ceiling sprinklers for storage application, 2005 Edition
FM Global Data Sheet 4-3N	Medium and high expansion foam systems, 2001 Edition
FM Global Data Sheet 7-11	Belt conveyors, 2005 Edition
FM Global Data Sheet 7-31	Storage of aerosol products, 2003 Edition
FM Global Data Sheet 8-1	Commodity classification, 2004 Edition
FM Global Data Sheet 8-18	Storage of hanging garments, 2000 Edition
FM Global Data Sheet 8-29	Refrigerated storage, 2000 Edition
FMRC 4880:1994	Approval requirements for Class 1 fire classification with no height restriction
LPCB LPS 1181: - - - -	Series of fire growth tests for LPCB approval and listing of construction product systems
Part 1:2005	Requirements and tests for built-up cladding and sandwich panel systems for use as the external envelope of buildings
Part 2:2005	Requirements and tests for sandwich panels and built up systems for use as internal construction in buildings
LPCB LPS 1208:2005	LPCB fire resistance requirements for elements of construction used to provide compartmentation
NFPA 11A-1999	Medium- and high-expansion foam systems
UBC 26-3	Room fire test standard for interior of foam plastic systems
UL 199:2005	Standard for automatic sprinklers for fire-protection service
UL 300:2005	Safety for fire testing of fire extinguishing systems for protection of restaurant cooking areas
UL 1626:2001	Standard for Residential sprinklers for fire-protection service

Environmental Protection Agency. *Cross-connection control manual.* Washington, DC: Office of ground water and drinking water, 2003.

Fire Offices' Committee. *Rules for automatic sprinkler installations*, 29th ed. London: Fire Offices' Committee, 1968.

New Zealand Building Code Handbook and compliance documents

NEW ZEALAND LEGISLATION

Building Act 2004
Building (Forms) Regulations 2004
Building (Specified Systems, Change the Use, and Earthquake-Prone Buildings) Regulations 2005
Building Regulations 1992
Chartered Professional Engineers of New Zealand Act 2002
Electricity Act 1992
Electricity Regulations 1997
Fire Service Act 1975
Fire Safety and Evacuation of Buildings Regulations 2006
Hazardous Substances and New Organisms (HSNO) Act 1996
Hazardous Substances (Classification) Regulations 2001
Resource Management Act (RMA)1991
Standards Act 1988

REVIEW OF STANDARDS

Suggestions for improvement of this Standard will be welcomed. They should be sent to the Chief Executive, Standards New Zealand, Private Bag 2439, Wellington 6140.

LATEST REVISIONS

The users of this Standard should ensure that their copies of the above-mentioned New Zealand Standards are the latest revisions. Amendments to referenced New Zealand and Joint Australian/New Zealand Standards can be found on **www.standards.co.nz**.

FOREWORD

This revised edition of NZS 4541 supersedes NZS 4541:2003. It provides rules for the design, installation, and maintenance of sprinkler systems so that systems reliably achieve their fire control function. That function is twofold: firstly, the fire should be controlled within a specified area and secondly, control should be achieved before levels of toxic by-products of combustion become life-threatening.

It is intended that the Compliance Documents to the New Zealand Building Code and the Fire Safety and Evacuation of Buildings Regulations will reference this edition of the Standard, NZS 4541:2007, as the means of compliance. This is subject to:

(a) Publication of an amendment to Acceptable Solution C/AS1 and F7/AS1 of the Compliance Documents to the New Zealand Building Code; and

(b) An amendment to the Fire Safety and Evacuation of Buildings Regulations.

These changes are expected to be made in the first half of 2008. Until then NZS 4541:2003 remains current as the means of compliance. Once NZS 4541:2003 is no longer referenced in the Acceptable Solution C/AS1 and F7/AS1 of the Compliance Documents to the New Zealand Building Code, and in the Fire Safety and Evacuation of Buildings Regulations, NZS 4541:2003 will be advertised for withdrawal by Standards New Zealand.

For this reason there will be a transition period with both NZS 4541:2003 and NZS 4541:2007 in force. It is hoped that users will apply the latest edition where circumstances enable this so that experience is built up in working with NZS 4541 2007 before NZS 4541:2003 is withdrawn.

If users require assistance over this interim period, the Committee recommends that guidance should be sought from territorial authorities, Standards New Zealand or the Fixed Fire Protection Formal Interpretation Committee.

Users of this edition of NZS 4541 should note that sprinkler systems certified under previous editions of NZS 4541 will not need to be upgraded as a result of the publication of NZS 4541:2007 and the proposed amendment to the Regulations. This is due to the 'grandfathering' clause in Appendix F, which specifically provides that such systems are deemed to comply with NZS 4541:2007 for the purposes of the Fire Safety and Evacuation of Buildings Regulations.

The basis of this Standard is protection of complete "firecells" or complete buildings or groups of buildings. The Standard has no integrity if applied to partial protection of areas that are not physically fire separated from others.

Users of this Standard need to see it as an integrated set of rules. The validity and effectiveness of any one rule is likely to depend on adherence to other rules. It is not possible to ignore or vary sections of this Standard, except where this is provided for in the Standard. The importance of detail cannot be over-emphasised. Experience in New Zealand, and internationally, has shown repeatedly that sprinkler system failure is likely to be the result of inattention to small details. Users of the Standard are encouraged to apply all parts of the document.

This revised Standard includes some significant changes from previous editions of the Standard, especially water supplies and high piled storage design criteria. Many other changes have been made throughout the Standard.

The revision of NZS 4541:2003 is based on the ability of many territorial authorities to supply at least one reliable public water supply.

Public water supplies have, in the past, been approved (or not approved) by the authority having jurisdiction, depending upon whether they met the reliability requirements set out in earlier editions of NZS 4541.

The authority having jurisdiction (AHJ) was replaced by a regime of sprinkler system certifiers (SSCs) from 2003. As a result, there is now no organisation responsible for ongoing monitoring of trends in the suitability of public water supplies to meet sprinkler system requirements.

The Fire Sprinkler Standards Committee is aware that some water supplies approved in the past, may not now comply with the requirements for an "approved" water supply under NZS 4541. There are a number of reasons why this deteriorating situation is occurring, such as:

(a) Water conservation measures which may include the installation of pressure reduction valves in public water mains, or shut down of water pumps during periods of the low draw-off, for example, during the early hours of the morning;

(b) Increased demand/draw-off from public water supplies;

(c) Ageing reticulations;

(d) Deteriorating reliability.

Added to these concerns is the vulnerability of public water supplies post earthquake and the vulnerability of reticulation pipework to earthquake damage.

It is important that water conservation measures are in place to conserve potable water supplies after an earthquake. Examples of such measures are automatic, seismic shock valves, or excess flow valves.

Fire following earthquake is a likely scenario, especially in areas where there is a reticulated gas system.[1]

It is recommended that those responsible for the design and specification of sprinkler systems advise building owners of the Committee's concerns at the declining suitability of many public water supplies for automatic sprinkler use, especially where the sprinkler system is reliant upon a public water supply.

Circumstances where reliance on public water supplies for automatic sprinkler use may require particular attention are:

(e) Where the proposed sprinkler system will have only a single town's main water supply, and the passive fire protection and fire egress requirements have been reduced, as permitted under the New Zealand Building Code, Compliance Document C/AS1, because sprinkler protection is provided. Indeed evacuation plans can be based on evacuation to a place of safety within the building. The Fire Safety and Evacuation of Building Regulations (made under the Fire Service Act) where there is an Approved Evacuation Scheme allow for staged evacuation to a place of safety within the building;

(f) Places of public entertainment/assembly, accommodation and so on, where multiple lives may be at risk in the event of sprinkler non-performance;

(g) Extra-high hazard sprinkler systems.

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[1] A report by the New Zealand Lifelines Study Tour following the 17 January 1995 Great Hanshin Earthquake, highlighted the vulnerability of cast iron pipework in earthquake prone regions – and cast iron pipework is quite common in New Zealand public water reticulations. The same report refers to 138 fires resulting from the earthquake, 77 of these fires involved more than one building, with approximately 240 deaths due to fire following the earthquake.

The requirement for the authority having jurisdiction to determine whether a water supply is seismically vulnerable was introduced in 1996 during the first revision of the Standard, after the enactment of the Building Act 1991. With the introduction of competitive sprinkler system certifiers, the ability to have one central body to review water supplies has disappeared. The Committee has asked the Government to address this in the Building Code, or following analysis, in the next revision of this Standard.

Changes to Part 9 of the Standard now reflect that the majority of developments in the protection of high piled storage are based on research and full scale testing in the USA. This has resulted in the Committee adopting a USA-based design approach for such hazards, as against the UK-based approach used in previous editions of the Standard. The change is significant, and includes fundamental changes such as the types of sprinklers to be used. The cooperation of Standards Australia in allowing the use of its work in adopting a USA-based approach in this Standard is gratefully acknowledged.

The role of the sprinkler system certifier (SSC) was re-examined to ensure that the advent of multiple Certifiers would not disadvantage building owners and other stakeholders involved in the life cycle of a sprinkler system. The Standard effectively places the basic design documentation and completion document in the public domain, subject to any confidentiality issues specified by the building owner.

In line with this review, the qualification of contractors was examined. Contractors will now be able to be partially listed within areas of expertise and experience. This is not intended to exclude contractors from competing in parts of the industry, but it is intended that if they venture into new fields, they will obtain provisional listing until competence is demonstrated. The key issue is that contractor listing is intended to indicate the ability and commitment of a contractor to fulfil their contractual obligations, so that building owners can expect that the end product will perform as expected. The Standard requires the SSC to work with a contractor to remedy any deficiencies in their operation before resorting to delisting them.

The levels of reliability required by this Standard are intended to maintain the existing record of satisfactory performance of sprinkler systems in New Zealand. Since the first systems were installed in the late 1880s, approved sprinklers have achieved their fire control function in better than 99.5 % of the fires in which they have operated. By contrast, most western countries achieve at best only 95 % successful performance.

In reviewing public comments made, the Committee has recommended to Standards New Zealand that a number of issues be reviewed during the next revision of the Standard. Additional recommendations and submissions on how the Standard can be improved are welcomed and can be directed to the Chief Executive, Standards New Zealand, Private Bag 2439, Wellington 6140.

AMENDMENTS

No.	*Date of issue*	*Description*	*Entered by, and date*
1	July 2009	Amendment No. 1 is a correction amendment, which has been developed to fix a small number of editorial errors in the Standard.	Incorporated in this edition, July 2009

Part 1
SCOPE AND GENERAL INFORMATION

101 SCOPE

This Standard is an integrated set of rules for the design, performance, installation and maintenance of automatic fire sprinkler systems in buildings or structures or in firecells which form part of a building.

102 INTERPRETATION

For the purposes of this Standard, the word 'shall' identifies a mandatory requirement for compliance with this Standard. The word 'should' refers to practices which are advised or recommended.

This Standard contains both 'Normative' and 'Informative' Appendices. A 'Normative' Appendix is an integral part of the Standard, so compliance with 'shall' statements is therefore part of conformance with the Standard. An 'Informative' Appendix provides advice and supporting information to assist with understanding and conformance with the Standard, but does not form part of its mandatory requirements. Thus the term 'should' refers to practices which are advised or recommended.

Clauses prefixed by 'C' and printed in italic type on a grey screen are intended as comments on the corresponding clauses. They are not to be taken as the only or complete interpretation of the corresponding clause. Commentary clauses should be used as guidance when considering the mandatory requirements of compliance with this Standard.

The foreword, commentary, notes, figures and informative appendices are included to assist interpretation of the substantive clauses of this Standard.

Notes to tables form part of the mandatory requirements of this Standard whereas notes elsewhere are for information and guidance only.

In this Standard values for various parameters have been expressed as conversions of values originally expressed in foot-pound-second units. In some cases a hard conversion (rounded to the nearest whole number) has been used; in others a soft conversion has been applied. For example, the value 305 mm derives from a hard conversion of 12 inches, whereas 300 mm is the value obtained by a soft conversion. As the original values have inevitably been rounded to rational numbers, engineering judgement must be applied in interpreting this Standard and allowing appropriate tolerances on values of particular parameters where approved by a SSC.

The full titles of documents cited in this Standard are given in the Referenced Documents immediately preceding the Foreword.

103 DEFINITIONS

For the purpose of this Standard, unless inconsistent with the context the following definitions apply:

NOTE – Part 9 has specific definitions. For details of these, see 902.

AEROSOL. A product in pressurised containers of up to 1 litre capacity designed to be released as a spray with the potential to 'rocket' when exposed to fire.

AISLE. See 902.1 for definition.

APPROVED. Subject to reported examination and acceptance by a SSC as meeting the normative criteria of the Standard including, where applicable, reliable field performance.

ASSUMED AREA OF OPERATION (OR ASSUMED MAXIMUM AREA OF OPERATION). The maximum expected area of sprinkler operation in a controlled fire.

BANDED PAPER. See 902.2 for definition.

BIN BOX STORAGE. See 902.3 for definition.

BUNDLED CABLES. Any group of data, signal or power cables in bundles, trays or cable marshalling areas with a total cross-sectional area of more than 750 mm^2 (which equates to a single 31 mm diameter cable, three 18 mm diameter cables, or ten 10 mm cables).

BUNDLED TYRES. See 902.4 for definition.

CARPET STORAGE. See 902.5 for definition.

CERTIFICATION. A statement of compliance of a sprinkler installation with this Standard.

CLOSED ARRAY (roll paper storage). See 902.6 for definition.

COMBINED MAIN. A pipe manifold normally located within a valve enclosure (404.1.2), supplied directly by more than one approved water supply, via check valves.

COMMODITY. The combination of product, packaging material, container and material handling aids (e.g. pallet) upon which commodity classification is based. (See 902.7.)

CONTRACTOR. An organisation or person that carries out one or more of the following:

(a) Project management;

(b) Design;

(c) Supply;

(d) Erection;

(e) Fabrication;

(f) Maintenance and testing of sprinkler systems (see 113); or

(g) Routine inspection.

CUT-OFF SPRINKLER. One or more sprinklers arranged to discharge over the face of a door or end wall of a passageway.

DESIGN DENSITY (DENSITY OF DISCHARGE). The depth of water discharged in a given period of time expressed as mm/min (which is equivalent to L/min.m^2).

DESIGN FLOW. The minimum flow rate required to supply the assumed area of operation with the specified density of discharge or the minimum flow rate required to operate the design number of sprinklers at the specified minimum operating pressure.

DESIGN POINT/S. The hydraulically remote assumed area/s of operation in a sprinkler system.

NOTE – Pipework downstream of the design point is pre-calculated and given in tables in the Standard. Design points are designated by letter on layout drawings and are classified as 4 or 18 sprinkler point and so on, according to the class of hazard. There will normally be more than one design point in any single installation.

DESIGN PRESSURE. The minimum pressure required immediately downstream of the alarm valve to induce the design flow for each area of the protected building.

DISTRIBUTION PIPES. Pipes directly feeding range pipes. (See figure 1.1.)

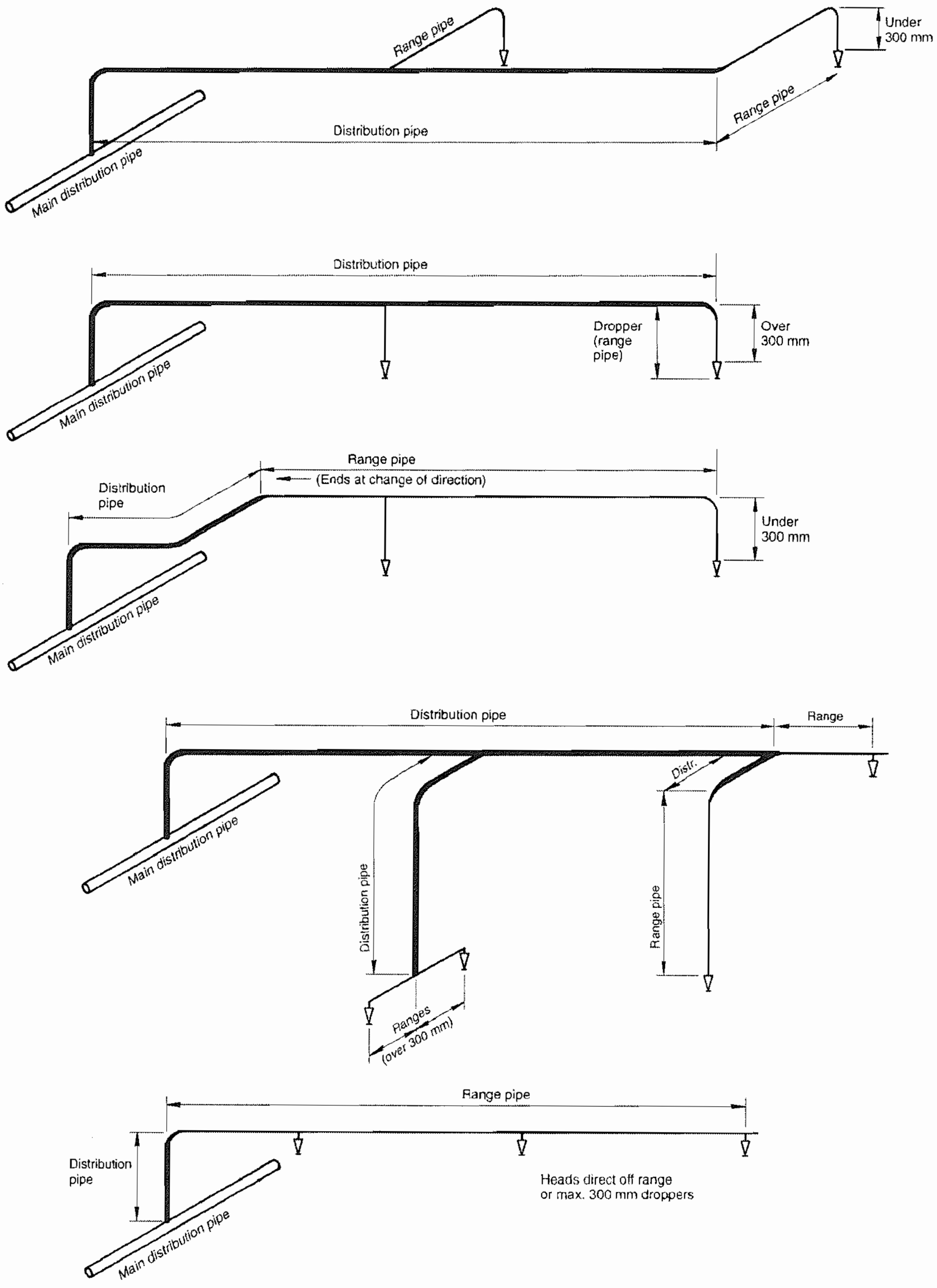


Figure 1.1 – Definition of range and distribution pipes

DOUBLE ROW RACK (DRR). See 902.8 for definition.

DRAFT CURTAIN. See 902.9 for definition.

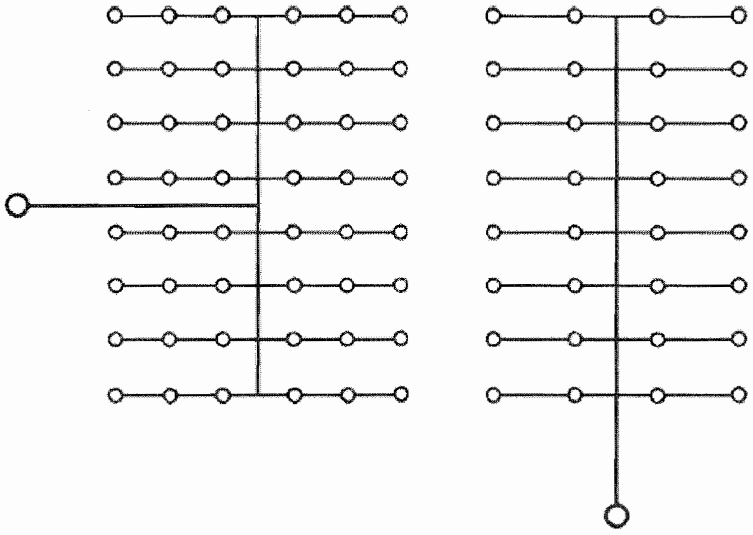
DRIVE-THROUGH RACKS. A racking system incorporating sufficient space for only one drive-through aisleway, the position of which is selected by moving individual racks sideways or a rack system of more than one pallet deep in which a forklift can drive into each pallet row to place or remove pallets.

DUNNAGE. See 902.10 for definition.

ENCAPSULATION. A method of packaging consisting of a plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity or a group of combustible commodities or combustible packages. Totally noncombustible commodities on wood pallets, enclosed only by a plastic sheet as described above, are not considered to be encapsulated.

Encapsulation only affects protection requirements for pervious Category 1, 2, 3 and 4 commodities that are stored in racks and protected by the type of sprinklers nominated in 904.1.1. Protection requirements for solid pile, palletised, shelf and bin box storage are not affected by the presence of encapsulation.

END-CENTRE ARRANGEMENT. An arrangement with range pipes on both sides of the distribution pipes. (See figure 1.2.)

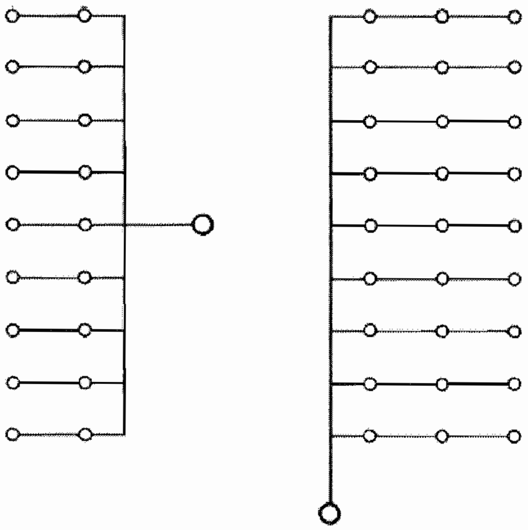


(a) Three end-centre
with central feed

(b) Two end-centre
with end feed

Figure 1.2 – Typical end-centre arrangement

END-SIDE ARRANGEMENT. An arrangement with range pipes on one side only of the distribution pipes. (See figure 1.3.)



(a) Two end-side with central feed

(b) Three end-side with end feed

Figure 1.3 – Typical end-side arrangement

FACE SPRINKLER. See 902.12 for definition.

FAST RESPONSE SPRINKLER. A sprinkler with a thermal element with a Response Time Index (RTI) of less than 50 $(m.s)^{1/2}$.

FIRECELL. Any space, including a group of contiguous spaces on the same or different levels within a building, which is enclosed by any combination of fire separations, external walls, roofs and floors.

FIRE DOOR. A doorset, single or multiple leaf, having a specific fire resistance rating and in certain situations a smoke control capability and forming part of a fire separation and arranged so that, in the event of a fire, if the door is not already closed it will close, and be held closed, automatically. Refer to AS/NZS 1905.1.

FIRE RESISTANCE RATING (FRR). The term used to classify fire resistance of primary and secondary elements as determined in the standard test for fire resistance, or in accordance with a specific calculation method verified by experimental data from standard fire resistance tests. It comprises three numbers giving the time in minutes for which each of the criteria, stability, integrity and insulation are satisfied, and is presented always in that order, the values specified being minima.

FIRE SEPARATION. Any building element which separates firecells or firecells and safepaths, and provides a specific fire resistance rating.

FLUE SPACES. See 902.13 for definition.

FULLY LOADED (tyre storage). See 902.14 for definition.

GREEN TYRES. See 902.15 for definition.

GRIDDED PIPE-CONFIGURATION. Installation pipework wherein there are multiple waterways to each sprinkler.

HEAVYWEIGHT PAPER (roll paper storage). See 902.16 for definition.

HORIZONTAL BARRIERS (within and above racks). See 902.17 for definition.

HORIZONTAL FLUE SPACE. See 902.18 for definition.

IN-PROCESS NON-RACK STORAGE (aerosols). See 902.19 for definition.

IN-RACK SPRINKLERS (IRS) See 902.20 for definition.

LIGHTWEIGHT PAPER (roll paper storage). See 902.22 for definition.

LISTED, LISTING. In reference to specific makes and models of equipment, materials, procedures, organisations and facilities required or permitted by this Standard, means that such has been determined by a Sprinkler System Certifier to meet relevant standards, and to be adequate for application where permitted or required by this Standard subject to any conditions or limitations specified in the listing.

LOCATIONS OTHER THAN WAREHOUSES (tyre storage). See 902.21 for definition.

LOOPED PIPE-CONFIGURATION. Installation pipework wherein there are multiple waterways to each range but only one way flow in the range.

LOOPED TERMINAL PIPE-CONFIGURATION. Installation pipework wherein there are multiple waterways, in the distribution pipework only, up to the design point.

MAIN DISTRIBUTION PIPES. Main pipes feeding distribution pipework.

MEDIUM WEIGHT PAPER (roll paper storage). See 902.23 for definition.

MOVABLE RACK. See 902.24 for definition.

MULTIPLE ROW RACK (MRR). See 902.25 for definition.

NETWORK UTILITY OPERATOR. The operator of the water supply system, irrespective of whether this is a local government agency or a private enterprise.

ON-FLOOR STORAGE (tyre storage). See 902.26 for definiton.

ON-SIDE STORAGE (tyre storage). See 902.27 for definition.

ON-TREAD STORAGE (tyre storage). See 902.28 for definition.

OPEN ARRAY (roll paper storage). See 902.29 for definition.

OPEN-TOP COMBUSTIBLE CONTAINERS. See 902.30 for definition.

PALLETISED STORAGE. See 902.31 for definition.

PARTIALLY LOADED (tyre storage). See 902.32 for definition.

PORTABLE RACK. See 902.33 for definition.

QUICK RESPONSE SPRINKLER. A sprinkler with a high thermal sensitivity and listed as a Quick Response Sprinkler.

RACK DEPTH. The width of the rack measured from aisle face to aisle face including any protruding storage. See figure 9.2(a).

RACK STORAGE. See 902.34 for definition.

RANGE PIPES. Any pipes on which sprinklers are attached either directly or through short arm pipes which except in the case of drops to individual sprinklers on extra light and ordinary hazard installations, do not exceed 300 mm in length. (See figure 1.1.)

ROOF/CEILING SPRINKLERS. See 902.35 for definition.

SHELF STORAGE. See 902.36 for definition.

SINGLE ROW RACK. See 902.37 for definition.

SOLID-PILE STORAGE. See 902.38 for definition.

SHELVING, SOLID OR SLATTED. See 902.39 for definition.

STANDARD ARRAY (roll paper storage). See 902.40 for definition.

SPECIAL RESPONSE SPRINKLER. A sprinkler listed as having a thermal element with an RTI of more than 50 $(m.s)^{1/2}$, and less than 80 $(m.s)^{1/2}$.

SPRINKLER INSTALLATION. That part of the system downstream from, and including, the main stop valve.

SPRINKLER SYSTEM. A system including:

(a) The water supply pipes from the boundary of the protected premises to the sprinkler valves;

(b) Any static water supply on the protected premises;

(c) Any pump providing water supply and its driving engine, motor and control equipment;

(d) The control valves and all appurtenances thereto;

(e) The main stop valve anti-interference device;

(f) Any fire alarm signalling device;

(g) Compressors, air receivers and related equipment forming part of a dry pipe system;

(h) All pipework, sprinklers and appurtenances downstream of the control valves;

(i) Storage restriction signs;

(j) First aid firefighting appliances to the extent required by this Standard;

NOTE – This is not a requirement for a sprinkler system to comply with the Compliance Documents of the New Zealand Building Code.

(k) Any fire rated wall, door or partition required by this Standard;

NOTE – This may not be a requirement for a sprinkler system to comply with the Compliance Documents of the New Zealand Building Code.

(l) Backflow prevention devices between the boundary and the main stop valve.

SPRINKLER SYSTEM CERTIFIER (SSC). An organisation accredited by an internationally recognised accreditation body to AS/NZS ISO/IEC 17020 as a Type A inspection body as competent to fulfil the roles as defined in this Standard.

STANDARD RESPONSE SPRINKLER. A sprinkler listed as having a thermal element with an RTI of more than 80 $(m.s)^{1/2}$.

STORAGE HEIGHT. See 902.41 for definition.

TERMINAL PIPE-CONFIGURATION (OR "CHRISTMAS TREE CONFIGURATION"). Installation pipework on which there is only one waterway to each sprinkler.

TYRE RACK (tyre storage). See 902.42 for definition.

VERTICAL BARRIERS. See 902.43 for definition.

WATER SUPPLY. The sources of water and includes the waterway and ancillary equipment up to but not including the sprinkler installation main stop valve.

104 INSPECTION, TESTING AND MAINTENANCE

To ensure that sprinkler systems operate reliably, they shall be tested, inspected and maintained in accordance with the requirements of Part 12 of this Standard, and that any defects that are identified shall be rectified in a timely manner.

105 SEISMIC RESISTANCE

105.1 General

All components of the sprinkler system shall be designed and installed so as to remain operational at the earthquake loadings specified in NZS 1170.5 having regard to the seismic design of the building elements which support, or are connected to, the system. Systems conforming with 403.12.1(b) shall satisfy this requirement with respect to pipework.

NOTE – In new buildings, the seismic design of the system should be developed in conjunction with that of the building.

105.2 Equipment

All installed sprinkler components and equipment shall be provided with horizontal and vertical restraint e.g. pumps, tanks, valves, engines and batteries, and all connections to the plant made secure, in accordance with NZS 1170.5.

106 WORKMANSHIP

106.1

Workmanship on all parts of a sprinkler system shall be consistent with best trade practice and no workmanship shall be permitted which will prevent the system from fulfilling its design function.

106.2

Materials and components shall be appropriate for the ambient environmental conditions, the service conditions which apply, and the intended service life.

107 TYPICAL ARRANGEMENTS

Typical layouts for sprinkler systems, water supplies and pipe arrays are provided in figure 1.1 to figure 1.4 inclusive. For detailed requirements see:

Part 4 – System components
Part 6 – Water supply.

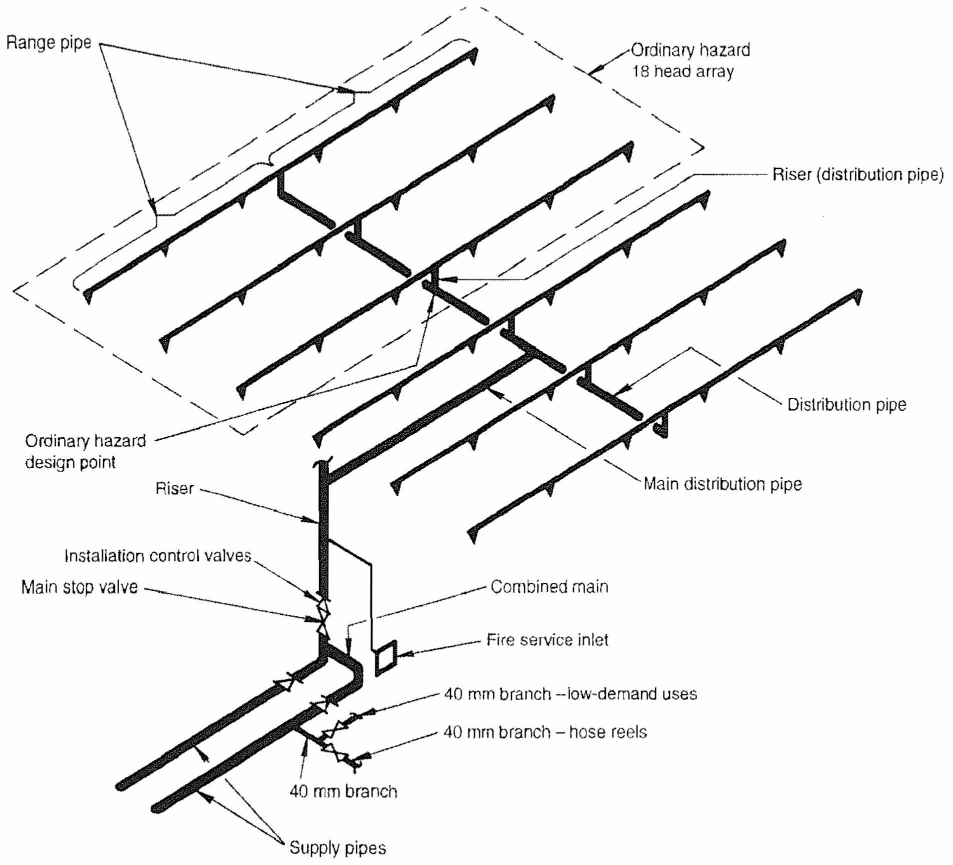

Range pipe
Ordinary hazard 18 head array
Riser (distribution pipe)
Distribution pipe
Main distribution pipe
Ordinary hazard design point
Riser
Installation control valves
Main stop valve
Combined main
Fire service inlet
40 mm branch –low-demand uses
40 mm branch – hose reels
40 mm branch
Supply pipes

Figure 1.4 – Typical fire sprinkler system

108 WELDING

108.1 Compliance

All welding on carbon steel pipes shall comply with the requirements of BS 2971 for Class 2 operating conditions except the qualification of welders for which 108.2 applies. The provision in BS 2971 to allow alternative joint preparation is permitted by this Standard whether or not there is a specific agreement between the contracting parties, provided that for butt welded pipes there is adequate weld penetration.

108.2 Qualification of welders

All welds shall be completed by welders holding current certification in terms of NZS 4711 for the type of welding employed.

109 HYDROSTATIC TESTS

109.1

Prior to completion, all sprinkler systems shall by hydrostatically tested at a minimum of 1,400 kPa for a period of two hours.

NOTE – To minimise the possibility of water damage from open pipe ends and the like, it may be advisable to carry out a low pressure air test before the introduction of water into the system.

109.2

Where portions of a sprinkler system are subjected to working pressures of greater than 1,050 kPa, they shall be tested at a pressure of 350 kPa in excess of system working pressure.

109.3

Extensions and alterations not exceeding 20 heads do not require hydrostatic testing.

109.4

The test pressure shall be read from a gauge located at the low elevation point of the system, or portion being tested.

109.5

When deluge systems are being tested, the nozzles shall be replaced with plugs, or alternatively, the operating elements of open sprinklers shall be removed after the test is completed.

109.6

A successful test will result in no measurable pressure drop using the gauges specified in 406.

109.7

The fire service inlet shall be hydrostatically tested to a working pressure of 1,600 kPa and a copy of the test certificate for this device shall be provided to a SSC with completion documentation provided in accordance with 112.2.

NOTE – This test is specified at a higher pressure than other sprinkler components following the field failure of a large square fabricated fire service inlet.

109.8

In addition to the standard hydrostatic test, dry pipe and pre-action systems shall be subjected to an air pressure leakage test at 300 kPa for 24 hours. Any leakage greater than 10 kPa (when adjusted for any temperature differential) shall be corrected.

110 ROLES AND RESPONSIBILITIES OF SSC

A SSC shall be responsible for certification of the sprinkler system. That role shall include, but not be limited to:

(a) Auditing design;

(b) Auditing installation;

(c) Auditing commissioning;

(d) Listing of contractors;

(e) Listing of equipment;

(f) Approving equivalent variations in the design and/or components;

(g) Maintaining records;

(h) Certification that the system complies with this Standard.

A SSC shall employ an appropriately qualified chartered professional engineer for the purpose of such certification.

Where the Standard refers to a SSC it shall be the SSC responsible for the certification of the particular automatic fire sprinkler system under consideration.

NOTE –

(1) It is desirable that the chartered professional engineer be a professional member of IPENZ in the fire practice college.

(2) Chartered professional engineers are as defined in the Chartered Professional Engineers of New Zealand Act.

111 FORMAL INTERPRETATIONS

111.1

Requests for interpretations, rulings or clarifications received by Standards New Zealand directly shall be reviewed by a subcommittee of the Automatic Fire Sprinkler Systems Committee (P 4541) which prepared this Standard for the Standards Council established under the Standards Act.

C111.1

The Fixed Fire Protection Formal Interpretation Committee which was constituted to deal with queries and interpretations of a number of fire protection Standards has jurisdiction to interpret the wording of the current published edition (both NZS 4541:2003 and NZS 4541:2007 until NZS 4541:2003 is withdrawn) of the relevant Standard only. Matters not mentioned in the Standard are outside the scope of this committee and should be dealt with according to normal business practice.

Requests for formal interpretations should be sent to the General Manager, Standards Development, Standards New Zealand, Private Bag 2439, Wellington 6140. An administration fee will be collected by Standards New Zealand for the processing of a request.

111.2

Formal interpretations shall be made when:

(a) An interpretation on a clause within this Standard is required;

(b) There is ambiguity in this Standard and clarification is required;

(c) Clarification of wording in this Standard is required because it does not achieve the intent agreed to by the committee;

(d) Fire testing or sprinkler system failures have been demonstrated and therefore the provisions of this Standard are inadequate, and a recommendation on amending the Standard is required and is submitted back to Standards New Zealand for consideration; or

(e) A recommendation is required because the wording within this Standard does not achieve the intent of the committee.

112 SPRINKLER SYSTEM CERTIFICATE OF COMPLIANCE METHODOLOGY

112.1

To enable a Sprinkler System Certifier (SSC) to evaluate for approval the following basic design decisions:

(a) Separation from unsprinklered fire loads;

(b) Density and assumed area of operation;

(c) Water supplies; and

(d) Method of alarm

the contractor shall, before installation is commenced, provide all necessary drawings, calculations and other descriptive information. Generally this shall include at least the following:

(e) Name by which protected premises will be known, and full address;

(f) Name of owner;

(g) Whether there are unprotected fire loads within 10 m of the protected premises;

(h) The nature of any concealed spaces within the protected premises;

(i) The means by which separation from unprotected areas or fire loads will be achieved;

(j) Relevant constructional details of ceilings, roofs, floors, exterior walls and walls separating sprinklered and non-sprinklered areas;

(k) The uses (occupancies) to which each part of the protected buildings will be put;

(l) Evidence of the owner's intentions with regard to the storage of combustibles;

(m) The hazard classifications, densities and area of operation proposed;

(n) For mixed hazard category storage, full details of the storage arrangements, proposed categories, proposed densities, and proposed areas of operation;

(o) The height of the highest sprinkler in each hazard classification area;

(p) If external sprinklers are used, the size of heads and the number designed to operate;

(q) The class of system proposed;

(r) The type of system proposed;

(s) A description of the nature and performance of the water supplies accompanied by a hydraulic graph of each, on which the design flows and pressures shall be marked together with the method and time of test:

   (i) Town's main supplies including the name of the street and the diameter of the mains
   (ii) Pumped supplies including the make, model, impeller size and rotational speed of the pump and the power rating and method of drive of the motor
   (iii) The capacity, location and filling method of tanks;

(t) The type and location of the fire brigade receiving equipment or other alarm to which the system will be connected;

(u) The number, size and location of alarm valves and the area to be protected by each installation;

(v) The number and type of hand operated fire-fighting appliances which will be provided;

(w) A plan showing the following information:

   (i) Scale
   (ii) North point
   (iii) Fire separations and doors
   (iv) External sprinklers
   (v) Hazard classifications, densities and assumed maximum areas of operation
   (vi) Height of highest sprinkler of each hazard classification area
   (vii) Area protected by each installation
   (viii) Location of fire sprinkler inlet and control valves
   (ix) Location of subsidiary stop valves
   (x) Location of drain valves
   (xi) Water supplies showing all valves between the source and alarm valve and, if a B2 system, the mains, interconnections and valves
   (xii) The power supply route for electric motor driven pumps including all switchgear. (If it is impracticable to supply this information at the design stage, it shall be provided as soon as possible thereafter)
   (xiii) The position of any fire alarm panel;

(x) A typical cross section showing the highest head(s), the height of the alarm valves and, where used, pump house, pump, tank and suction inlet;

(y) Details and location of alarm devices including pressure switches, isolation switches and any flow switches;

(z) In the case of an extension to an existing system, where the floor area of the extension exceeds that protected by 18 sprinkler heads, all the above information with:

  (i) Details of the water supplies for the system before and after extension

  (ii) A plan showing the total protected areas before and after extension;

(aa) A statement as to whether the installation is to be fully hydraulically calculated;

(bb) The valve opening pressure differential of the alarm valve to be used; and

(cc) For special systems such as Suppression mode sprinklers, dry pipe systems and antifreeze systems, any further information that a SSC may require.

112.2

Before final inspection, the contractor shall provide to a SSC:

(a) A notice of completion;

(b) As-built sprinkler and pipe layout plans with seismic resistance provisions, including whether the design is to 403.12.1(a) or (b);

(c) Hydraulic calculations;

(d) For fully hydraulically calculated installations, the information specified in 1006.2;

(e) A copy of the current data sheet for each type of residential head used;

NOTE – A contractor may agree an administrative procedure with a SSC whereby a data sheet reference may be used when the authority has the data sheet on file;

(f) Any other relevant information such as fire reports, building consent requirements, etc;

(g) Identification of any changes between the proposed design and the installed system including revised design proposal forms and block diagrams; and

(h) A copy of the pressure test certificate for the fire service inlet assembly (see 109.7).

112.3

If so required by a SSC, the contractor shall attend the final inspection and operate any pumps or other equipment.

112.4

A SSC shall provide the following approvals:

(a) A written acceptance or rejection of the basic design decisions, descriptively specifying the basis of the approvals given; and

(b) After final inspection, and if the system is found to comply with the Standard, a written certificate of compliance, (as specified in Appendix U), which shall have currency for not more than 28 months, unless compliance no longer remains due to changes or deterioration of the sprinkler system, building or its contents. See figure U1.

112.5

A copy of the certificate of compliance shall be displayed in a permanent holder at the control valves of each sprinkler system.

112.6

For systems installed to this Standard, a SSC shall make available to listed contractors the information contained in 112.1, 112.2 and 112.4, subject to receipt of consent from the building owner, where practical.

113 LISTING OF CONTRACTORS

113.1

All work on sprinkler systems shall be undertaken under the supervision of listed contractors.

113.2

Only those contractors which a SSC has determined satisfy the criteria set out in Appendix R shall be listed.

113.3

The form of listing shall be by means of a certificate in the form determined by a SSC. An example certificate is shown in Appendix S.

The certificate shall include at least the following information:

(a) The legal name and physical address of the contractor;

(b) The names of key personnel with their scope and grade of listing. This information may be included in a schedule to the certificate;

(c) The scope of listing, giving the work for which the contractor is listed, in accordance with Appendix R, table R1;

(d) Whether the listing is provisional or full;

(e) The date from which the listing takes effect;

(f) The date of listing expiry, or period of validity of the certificate;

(g) The name and authorising signature of a SSC senior manager or principal, plus date of signing.

(h) A unique certificate number;

(i) The SSC's legal name.

113.4

The listing shall have currency from date of issue for a period of 12 months for provisional listing or 24 months for full listing.

113.5

Contractors involved in routine inspections shall be accredited by an internationally recognised accreditation body to AS/NZS ISO/IEC 17020 as a Type A inspection body to inspect fire sprinkler systems for compliance with NZS 4541.

113.6

Other than for routine inspection contractors, provisional listing shall be awarded upon compliance to all requirements of the criteria and standards of competence with the exception of AS/NZS ISO 9000 certification and the completion of a fire sprinkler system.

NOTE – Provisional listing is the process by which a contractor with limited experience may become fully listed. The listing SSC may require additional inspections of various aspects of the contractor's work to ensure that installed systems are fully compliant with the Standard.

113.7

Full listing shall be awarded upon compliance to all requirements of the criteria and standards of competence, including a current AS/NZS ISO 9000 certification and satisfactory performance of design and construction as assessed by the listing SSC.

113.8

The contractor's quality management system shall be certified to AS/NZS ISO 9000 by a certification body independently accredited to ISO Guide 62 by an internationally recognised accreditation body (e.g. JAS-ANZ).

The scope of the AS/NZS ISO 9000 certification shall cover the activities and systems applicable to the contractor's listing.

114 LISTING OF EQUIPMENT

114.1

Only equipment which a SSC considers satisfy the criteria, as set out in Appendix T, shall be listed.

114.2

The form of listing shall be by means of a duly completed certificate in the form set out in Appendix T.

114.3

In listing equipment, materials, procedures, organisations or facilities, a SSC shall determine that any specific requirements of this Standard have been met and that there is sound evidence to indicate reliability of performance.

114.4

Items of equipment having Underwriters' Laboratories (UL), Factory Mutual Approvals (FM Global) or Loss Prevention Council (LPC) approval or listing for equivalent service, shall on presentation of evidence of such approval or listing to a SSC, be listed pursuant to this Standard unless a SSC considers that the approved or listed item is not suitable or is insufficiently reliable. Reasons for any decision not to list shall be provided by a SSC.

114.5

Listings shall be limited to the tenor and qualifications of a SSC listing document and shall cease to have effect from the date of any signed notice of withdrawal of listing issued by a SSC.

115 WITHDRAWAL OF LISTING

A SSC shall withdraw any listing of a contractor or equipment if it is found on examination of the work or the equipment to be defective, or to have performed inadequately or in an unreliable manner. Any withdrawal of contractors or equipment shall take place in accordance with Appendix R5(a) or Appendix T2(b), and only if there is no evidence of corrective action being undertaken to remedy the deficiency.

116 EXISTING INSTALLATIONS

This Standard does not require that systems approved to previous editions of NZS 4541 be upgraded. For the purposes of complying with legislation, such as the New Zealand Building Code and the Fire Safety and Evacuation of Buildings regulations, existing sprinkler systems that are certified as complying with previous editions of NZS 4541 may, for the purposes of that legislation, be deemed to meet the requirements of NZS 4541:2007.

Existing sprinkler protected buildings subject to alterations, additions or a change of use may require the sprinkler system to be upgraded as described in Appendix F.

NOTE –

(1) If an existing building is being altered (including additions), the provisions of Section 112 of the Building Act apply.

(2) If a building undergoes a change of use, the provisions of Section 115 of the Building Act apply.

(3) For information on change of use, reference should be made to the Building (specified systems, change the use, and earthquake-prone buildings) Regulations. A change of use would potentially include a change in the types of goods being stored in the building, or the manner (particularly the height) in which they are stored, which would increase or change the design basis required for the system.

Part 2
BASIC RULES OF DESIGN

201 INSTALLER TO BE LISTED

All work on sprinkler systems shall be undertaken under the supervision of listed contractors.

202 MINIMUM REQUIRED DISCHARGE AND DESIGN FLOW

202.1

Every sprinkler system shall be designed to deliver a minimum flow (the "design flow") to each area of the protected building.

202.2

Water supplies shall be sized to permit the design flow to be maintained for a period specified by this Standard.

202.3

To establish the minimum required discharge, the fire hazard, (or intended fire hazard), of each area of the protected building shall be determined in accordance with this Standard and shall be specifically approved. Thereafter, the minimum required discharge and the assumed area of operation shall be determined by reference to Parts 7, 8 or 9 as appropriate.

NOTE – The expression "fire hazard" in this context is not intended to have the same meaning given to this expression in the New Zealand Building Code.

203 DETERMINATION OF FIRE HAZARD

203.1 Classes of occupancy

203.1.1

Three broad classes of fire hazard are hereby established:

(a) Extra light hazard (ELH): Non-industrial occupancies where the amount and combustibility of the contents is low;

(b) Ordinary hazard (OH): Commercial and industrial occupancies involving the handling, processing and storage of mainly ordinary combustible materials unlikely to develop intensely burning fires in the initial stages. This occupancy class is further divided, for the purposes of determining assumed area of operation, into four sub-groups – viz:

   (i) Group 1(OH1)
   (ii) Group 2(OH2)
   (iii) Group 3(OH3)
   (iv) Group 3 Special (OH3S);

   NOTE – The term storage includes the warehousing or the temporary depositing of goods or materials while undergoing process.

(c) Extra high hazard (EHH): Commercial and industrial occupancies having high fire loads:

   (i) Where the materials handled or processed are mainly of an extra hazardous nature likely to develop rapid and intensely burning fire (extra high hazard – process risk)
   (ii) Involving high piling of goods beyond the limits specified in 203.3.4.

203.1.2

Every area of the protected building shall be assigned to one of the above classes and/or respective subgroups according to the following three factors of fire hazard:

(a) The fire load;

(b) The rate of fire spread and development;

(c) The extent of potential fire spread.

203.2 Classification schedules of occupancies

203.2.1

Table 2.1 is a representative schedule of occupancies to which is assigned a particular hazard classification. For ease of reference, the schedule is divided into 8 generic groups.

NOTE – The table is not an authoritative guide to the occupancy classification to which a building should be protected. For example, while schools would generally be protected to extra light hazard classification, areas such as technology blocks, auditoriums and laboratories should be assessed on a case by case basis as a higher classification may be warranted.

203.2.2

Where, with respect to the three factors of fire hazard referred to in 203.1.2, the fire hazard of a particular area of the protected building is typically that of one of the occupancies in the schedule, then the hazard classification of that area shall be that specified in table 2.1.

203.2.3

In other cases, the classification shall be that of an occupancy in the schedule which, having regard to each of the three factors of fire hazard, most closely approximates the fire hazard of the area being classified.

203.2.4

Classification of an area as ordinary hazard occupancy is subject to storage of combustible materials not exceeding the height limitations specified in 203.3.4, otherwise the classification shall be extra high hazard requiring the density appropriate to the storage pattern. See also 903.6 for Incidental EHH Storage of less than 20 m^2.

203.2.5

Apart from storage present in small storage areas and drying rooms, protected in the manner set down in 704, any occupancy which would otherwise be extra light hazard shall, if used for storage of combustibles, be ordinary hazard Group 3 (subject to 203.2.4).

203.2.6

Rooms of ordinary hazard group 1, 2 and 3 occupancies in buildings or fire cells of predominantly extra light hazard occupancies may be protected using a room design basis as follows:

(a) The room shall be separated from the extra light hazard area by a lintel of at least 200 mm depth;

(b) The total number of sprinklers calculated to operate in the ordinary hazard room shall be the total number of heads in the room, noting that the maximum number of heads operating shall not exceed the limits specified in Part 8.

NOTE – Examples of occupancies where this approach may be applied include OH3 retail stores in ELH hotel lobbies or OH2 metalworking shops in schools.

Table 2.1 – Representative schedule of occupancies

(a) *Educational*	
Art galleries	ELH
Libraries (excluding stack rooms)	ELH
Schools	ELH
Universities	ELH
Teaching laboratories (using flammable liquids)	OH3
(b) *Residential*	
Boarding houses	ELH
Hospitals	ELH
Hotels (residential portion)	ELH
Motels (residential portion)	ELH
Prisons	ELH
Residential clubs	ELH
Youth hostels	ELH
(c) *Public assembly*	
Airport public areas (excluding kiosks)	ELH
Amusement arcades	OH3
Bars, cafeterias, dining rooms, meeting rooms and restaurants	OH1
Churches	OH1
Cinemas/auditoriums/theatres	OH3
Clubs (non-residential)	OH3
Exhibition halls	OH3S
Exhibition halls (ceilings greater than 18 m)	EHH Process
Grandstands	OH3
Gymnasiums (excluding equipment storage)	OH1
Museums (unless otherwise approved)	OH3
Night clubs	OH3
Recreation ground and racecourse pavilions	OH1
(d) *Energy supply*	
Briquette and smokeless fuels	OH3
Coal fired plants	EHH Process
Electricity generation and distribution	Refer NFPA
L.P.G. storage	EHH Process
(e) *Commercial and mercantile*	
Commercial laundries	OH3
Retail shops and malls	OH3
Offices, staff amenity and cafeteria areas	ELH
(f) *Processing and production*	
Aircraft engine testing	EHH Process
Agricultural produce:	
– high moisture content (e.g. fruit and vegetables)	OH1
– low moisture content (e.g. grain, straw and tobacco)	OH3
Animal and animal products:	
– cutting, boning and packing	OH2
– other processing	OH3
Beverages – non-alcoholic:	
– processing	OH2
– storage	OH3
Breweries:	
– processing	OH2
– storage	OH3
Boat building sheds	OH3S
Celluloid manufacturers & celluloid goods' manufacturers	EHH Process
Combustible compounds and chemicals (excluding manufacture or extensive use of flammable liquids)	OH3
Dairy produce:	
– casein, milk powder, butter and cheese	OH3
– other dairy products	OH2
Distilleries	EHH Process
Electrical/electronic manufacturing and assembly (predominantly plastic components)	EHH Process
Fish:	
– cutting and packing	OH2
– other processing and products	OH3
Firelighter manufacturers	EHH Process
Fireworks and explosives	EHH Process
Flammable liquids:	
– laboratories	OH3
– processing	OH3S
– storage	EHH
– spraying	EHH Process
Floor cloth and linoleum manufacturers	EHH Process
Inert materials and compounds	OH1
Leather, skins and furs	OH3
Metal working and engineering workshops	OH2
Paper and paper products	OH3
Plastic goods: manufacturing and process works (where plastic is one of the basic materials in the operation)	EHH Process
Resin and turpentine manufacturers	EHH Process
Rubber:	
– foamed	EHH Process
– other than foamed	OH3
Tar distillers	EHH Process
Textile fibres and products	OH3
Wood and wood products	OH3
(g) *Miscellaneous*	
Aircraft hangers	EHH Process
Boat houses	OH3
Bus and tram barns	OH3
Car parking	OH2
Cinematographic and T.V. production studios	OH3
Combustible piers and bridges	OH3
Heavy vehicle repair workshops	EHH Process
Motor vehicle repair garages	OH3
Plant rooms (building services) in commercial buildings only	OH1
Plant rooms (industrial)	OH2
(h) *Shipping and storage*	
Aerosol containers with more than 25% flammable product	EHH S C*
Baled fibres and waste paper storage	EHH S C*
Carpet storage	EHH S C*
Container stuffing and unstuffing sheds (storage, as defined in 203.3.4)	OH3S
Distilled spirits storage	EHH S C*
General warehousing and storage (storage, as defined in 203.3.4)	OH3
Hanging garments storage	EHH S C*
Idle pallet storage	EHH S C*
Library stack rooms	OH3
Theatrical scenery store	EHH Process
Transit sheds (storage, as defined in 203.3.4)	OH3
Roll paper storage	EHH S C*
Rubber tyre storage	EHH S C*

* EHH Special Commodity – see 203.3.3 and 907.

203.3 High-piled storage risks

203.3.1 *Sprinkler protection*

The sprinkler protection of high-piled storage risks depends on the method of storage, the hazardous nature of the materials being stored and the height of the storage. The categorisation of materials and products listed in Appendix B should be considered as indicative examples only. Considered judgement must be exercised in order to fully protect the storage area effectively. Classifying products based solely on the following categories can be misleading because of the variances in the materials or configurations from one model or manufacturer to another.

The relative hazard of a commodity is a function of both the material and its packaging and storage configuration. For example, metal parts in cardboard cartons would be considered as Category 1, however, when the parts are handled and stored within plastic boxes, the arrangement should be protected as a plastic (Category 5 or 6) commodity. This is due to the plastic boxes increasing the overall total fire load beyond the level for which a Category 1 based sprinkler system is designed.

Alternatively, plastic products in cardboard cartons are protected to Category 5 or 6 depending on the type of plastic, but should those same items be stored in open topped metal boxes, then the classification can be taken to be Category 3. In this example, the metal containers limit the amount of air available for burning and reduce the number of continuous vertical and horizontal plastic surfaces.

203.3.2 *Mixed category goods*

In many warehouse environments a variety of goods is being stored. It is not suitable to 'average out' the categories of the commodities being stored. The fire protection shall be based upon the highest hazard commodity present. An alternative is to segregate the higher class materials and protect them accordingly.

However, maintaining separation of higher hazard goods can prove very difficult in normal warehouse operations. Therefore, unless the quantity and location of higher hazard goods can be strictly controlled, the overall classification of the storage area shall be based upon the highest class of goods present.

203.3.2.1 *Use of plastic pallets for storage of commodities*

Unless listed pallets are used to support stored commodities, the classification of the commodity shall be increased by one level. The additional weight of the plastic pallet shall not be factored into the plastic weight of the commodity itself. The classification shall be increased as follows:

Category 1, Category 2, Category 3 and Category 4, shall be increased to Category 2, Category 3, Category 4 and Category 5, respectively. A change in class classification shall not be needed when the commodity itself is considered a plastic.

203.3.2.2 *Free flowing materials*

Solid piled storage of plastic or paper bags and sacks of greater than 0.025 m^3 capacity containing free flowing inert commodities such as minerals, seeds, powdered detergents, and salt in powdered, granular, flake, pellet or similar forms, on wooden pallets can be classified as noncombustible commodities. A fire will burn through the bags causing the material to flow or spill out, filling up the flue spaces and reducing the fire intensity. This same effect does not occur in racks. Protect inert goods in this form stored in racks as Class 1 commodities. This does not apply to plastics.

203.3.2.3 *Expanded plastic commodities*

Foamed or cellular (expanded) plastics are those in which the density is reduced by the presence of numerous small cells throughout their mass. The fire risk associated with these materials is considered significantly higher than 'unexpanded' goods of the same materials.

203.3.2.4 *High hazard – Storage occupancies – Category 1*

Category 1 commodities are equivalent to noncombustible products stored on wood pallets, within ordinary corrugated cardboard cartons.

203.3.2.5 *High hazard – Storage occupancies – Category 2*

Category 2 commodities are equivalent to Category 1 products stored in wooden crates and boxes, within multiple thickness cardboard cartons or similarly combustible packaging materials on wood pallets.

203.3.2.6 *High hazard – Storage occupancies – Category 3*

Category 3 commodities are equivalent to ordinary combustible products, such as packaged or unpackaged wood, paper or natural fibre cloth, or products made from these materials on wood pallets. Class 3 commodities also generally include Category 1 and Category 2 goods or paper goods containing no more than 5 % plastics, either by weight or volume.

NOTE – Category 3 commodities would also include those plastic products classified as 'Group C Plastics' in ANSI/NFPA 13 and Factory Mutual Global's Loss Prevention Data Sheets 8-1. Examples include rigid or lightly plasticised PVC products (e.g. pipe and pipe fittings), melamine, fluoro plastics and urea formaldehyde.

203.3.2.7 *High hazard – Storage occupancies – Category 4*

Category 4 goods are equivalent to Category 1, 2 and 3 goods containing in them, or in their packaging, no more than 25 % by volume of expanded (foamed) plastic or 15 % by weight of unexpanded plastics in cardboard cartons.

203.3.2.8 *High hazard – Storage occupancies – Category 5*

Category 5 products are equivalent to uncartoned or cartoned unexpanded plastics or cartoned expanded plastics.

NOTE – Some plastics have a heat of combustion and a burning rate similar to those of ordinary combustibles, and can be treated and protected as a Class 3 commodity. Generally, these materials would be classified as 'Group C'.

203.3.2.9 *High hazard – Storage occupancies – Category 6*

Category 6 plastic commodities are equivalent to expanded and exposed plastics.

NOTE – Further guidance may be available in Factory Mutual Global's Loss Prevention Data 8–1 and in ANSI/NFPA 13.

203.3.2.10 *Encapsulation of pervious goods*

Encapsulation (see 902.11) only effects the protection requirements of pervious Category 1, 2, 3 and 4 goods that are stored in racks and protected by the types of sprinklers nominated in 904.1.1. The design density is adjusted as directed by the respective table entry notations.

203.3.2.11

Where the provisions of 203.3.2.1 and 203.3.2.10 both need to be considered, the most onerous of the single provisions of these clauses shall apply.

203.3.3 *Special commodities*

The special commodity categories detailed represent materials, products and/or methods of storage that require specific sprinkler protection considerations. See 907.

203.3.4 *Ordinary hazard storage limits*

Where combustible materials are stacked or stored beyond the heights specified in table 2.2, the occupancy class of that area shall change from ordinary hazard to extra high hazard. These heights depend on the fire hazard category of the goods or materials being stored (including, the fire hazard category of any packaging materials associated with such goods) and the manner of stacking. See also 203.2.4 and 903.6.

Height of storage shall be measured from the floor to the top of the stored materials (including packaging) under consideration.

Table 2.2 – Ordinary hazard storage limits

Fire hazard category	**All mercantile storage** (m)
1	3.5
2	3.0
3	2.4
4	2.2
5	2.0
6	1.2

For design purposes the owner of the building or a consulting professional engineer or architect acting with the authority of the owner, shall make a signed declaration as to the owner's storage intentions regarding maximum height above the floor using the form provided for in Appendix A.

NOTE – The intention of this clause is to provide maximum storage heights to normal ordinary hazard occupancies. For example, these limitations would apply to retail type occupancies such as supermarkets using gondola type display shelving. If the storage exceeds the limitations in the table and/or the limitations of 903.6, then the requirements of Part 9 shall apply. Where an occupancy is primarily a storage occupancy, a higher level of reliability and flexibility may be provided by adopting a design approach using Part 9, even if the heights of goods stored are below that stated in the table above.

203.3.5

Appendix B is a representative schedule of materials which have been assigned to a fire hazard category. The same material can appear in more than one category depending upon its physical form, the wrapping or packaging and the method of storage.

203.3.6

Where, with respect to the three factors referred to in 203.1.2, the fire hazard of a particular material is typically that of one of the materials included in Appendix B, the fire hazard category of the material under consideration shall be the same as that material.

203.3.7

In other cases, the material shall be assigned to the category which, having regard to the three factors of fire hazard, includes materials with a fire hazard that most closely approximates the material in question.

203.3.8

The fire hazard category of a particular material is subject to approval.

203.3.9

Some aerosols contain a proportion of flammable products other than the propellant. If exposed to fire, aerosols with more than 25 % flammable product can cause intense burning and may rocket with a flaming trail of contents. The combustibility of the propellant has little impact on fire behaviour.

Storage of aerosols containing more than 25 % flammable products, as defined in 907.7, is deemed to be a special commodity and shall be protected in the manner described in 907.7.

Storage of aerosols containing 25 % or less flammable liquid, (i.e. Level 1 aerosols) are subject to the rules for ordinary hazard and extra high hazard.

203.4 Process risks

203.4.1

Those occupancies or storage situations which, notwithstanding the amount and arrangement of stored combustibles, will produce rapid and intense burning fires requiring higher densities than those for ordinary hazard, shall be protected as extra high hazard "process" risks.

203.4.2

The density and assumed maximum area of operation shall be as specified in 905.11. For occupancies or processes not included in table 9.7 but which present a process risk, the density and area of operation shall be approved by a SSC having regard to the three factors of fire hazard specified in 203.1.2 and relating these to the occupancies or processes included in table 9.7.

203.5 Other flammable liquid hazards

203.5.1

A SSC may require special provisions for the protection of Class 3.1A, B and C Hazard Classification flammable liquids.

Special protection required may include:

(a) For Class 3.1A and B flammable liquids in plastic containers: deluge protection and storage in a fire separated, bunded and/or drained area of limited size, in order to limit fire spread;

(b) For Class 3.1A, B and C flammable liquids in pressure-relieving metal containers, and Class 3.1C flammable liquids in plastic containers: Closed-head wet pipe sprinklers in system designed to apply aqueous film forming foam with a discharge duration of at least 15 minutes at the design discharge density. Where the actual discharge density exceeds the design discharge density a proportionate reduction in foam discharge duration is permitted down to a minimum of 10 minutes.

NOTE – There are differences between flammable liquid classification definitions in the Hazardous Substances (Classification) Regulations and ANSI/NFPA 30. ANSI/NFPA 30 protection criteria shall be based upon NFPA flammable liquid classifications. See table 2.3 for guidance.

Table 2.3 – Comparison of classification of flammable liquids designations as specified in ANSI/NFPA 30 and Hazardous Substances (Classification) Regulations (Informative)

ANSI/NFPA 30 designation			**HSNO classification**		
Liquid classification	Flash point (°C)	Boiling point (°C)	Liquid classification	Flash point (°C)	Boiling point (°C)
IA	<22.8	<37.8	3.1A	<23	≤35
IB	<22.8	≥37.8	3.1B	<23	>35
IC	22.8≤FP<37.8	NA	3.1C	23≤FP≤60	NA
II	37.8≤FP<60	NA	3.1C	23≤FP≤60	NA
IIIA	60≤FP <93	NA	3.1D	60<FP≤93	NA
IIIB	≥93	NA	NA	NA	NA

For deluge systems and foam systems the density, area of operation and placement of sprinklers shall be based upon an appropriate ANSI/NFPA Code. Water spray systems shall be based on ANSI/NFPA 15 and 30. Foam systems design shall be based on ANSI/NFPA 16. Drainage systems shall terminate in a safe place and have due regard to environmental considerations.

203.5.2

Equipment within or adjacent to the protected building and which contains flammable liquids, including transformers, lubricating oil and hydraulic systems, and heat-transfer fluid systems may require the use of water spray systems where the quantity of flammable liquid which could become involved in the fire would present a greater fire load than the remainder of the occupancy. Such systems shall form part of the sprinkler systems and be designed to provide densities specified in ANSI/NFPA 15.

203.5.3 *Flammable liquids in retail areas*

203.5.3.1

Flammable liquids in retail glass, plastic, and metal containers may be stored and displayed in ordinary hazard Group 3 retail areas protected by a minimum of an ordinary hazard Group 3 sprinkler system, subject to the following limitations:

(a) The maximum allowable storage height is 2.4 m;

A1 (b) Class 3.1A and B flammable liquids in containers of greater than 1 litre capacity shall not be stored in retail areas designed to ordinary hazard group 3;

(c) Class 3.1C and D flammable liquids in containers of greater than 10 litres capacity shall not be stored in retail areas designed to ordinary hazard group 3;

(d) Adjacent storage areas (see 203.5.3.2) of flammable liquids in retail areas shall be separated by a horizontal distance of at least 15 metres, or be in an adjacent fire cell.

For the purposes of this clause, a fire cell is defined as providing a FRR of at least –/60/60.

203.5.3.2

The maximum volumes of flammable liquids allowed to be stored in ordinary hazard group 3 retail occupancies protected to a minimum of ordinary hazard group 3 occupancy are as follows:

(a) The maximum volume of Class 3.1A and B flammable liquids in any one storage area is 100 litres;

(b) The maximum aggregate volume of other classes of flammable liquids in any one storage area is 1,000 litres.

Storage or display of Class 3.1A, B or C flammable liquids is not permitted in basements.

If the required storage criteria exceed the limits specified in these clauses, alternative design criteria may be found in Part 9, or ANSI/NFPA 30.

203.5.4

Fixed Liquid Petroleum Gas storage vessels, or quantities of more than 100 kg in portable cylinders, may require water spray systems where the risk of BLEVE (Boiling liquid, expanding vapour explosion) would expose the protected building and occupants (see table 9.7).

NOTE – Typically one or two LPG cylinders will only require standard sprinklers for coverage or exposure protection.

203.6 Materials with a high spread of flame or exposed, extruded or expanded plastic materials on walls, ceilings and undersides of roofs

203.6.1

Where the surface of walls, or the underside of any roof, ceiling or mezzanine floor is of expanded plastic, the surfaces shall be protected from ignition by complying with the requirements of the Approved Document for the New Zealand Building Code C/AS1.

203.6.2

Surface treatments that use exposed combustible thermoplastic and thermosetting plastics on walls, ceilings and under roof surfaces that have not been tested and certified as having lower ignitability/combustibility properties by FM/LPCB or other accredited laboratories that have conducted full scale fire testing, and do not meet the requirements of the compliance documents published as a means of complying with the New Zealand Building Code, cannot be protected by automatic sprinkler systems. Due to the nature of these products and their application there is no suitable sprinkler protection currently available and advice should be sought from a suitably qualified fire engineer for an engineered solution for the protection of these buildings.

Any other material having similar burning characteristics regarding heat evolution and spread of flame shall be subject to the same requirements.

NOTE –

(1) The results of small-scale fire testing such as defined in AS/NZS 1530.3 cannot be used in isolation as evidence of compliance with this clause.

(2) Materials which have passed the Factory Mutual corner test and listed as Class 1 for the particular purpose are deemed to be acceptable for listing purposes.

204 EXTENT OF SPRINKLER PROTECTION

204.1

Any building which is required to be sprinkler protected in accordance with this Standard shall be sprinklered throughout except where the omission of sprinklers is specifically permitted by the Standard. Otherwise the sprinkler system shall be deemed not to comply with this Standard.

204.2

Any firecell of any building which is required to be sprinkler protected in accordance with this Standard shall be sprinklered throughout except where the omission of sprinklers is specifically permitted by this Standard. Otherwise the sprinkler system shall be deemed not to comply with this Standard.

205 FIRE LOADS ADJOINING, LINKED, OR ADJACENT TO THE SPRINKLER PROTECTED BUILDING OR SPRINKLER PROTECTED FIRECELL

205.1 General

205.1.1

In order to prevent the spread of fire and the operation of sprinklers inside a sprinkler protected building or sprinkler protected firecell as a result of a fire in some other building, firecell, structure or accumulation of combustibles, the sprinkler protected building or sprinkler protected firecell shall be effectively separated in the manner required by this Standard.

205.1.2

Separation requirements shall not apply in the case of any building under the same ownership or control as the sprinkler protected building if that other building is a sprinkler protected building. If the protected building sprinkler system does not comply with this Standard, separation requirements shall be subject to the approval of a SSC.

205.1.3

Separation may in general be achieved:

(a) In a sprinkler protected firecell, by means of fire separations, external walls, roofs and floors whereby fires in an unsprinklered firecell cannot be transmitted into the sprinkler protected firecell irrespective of the presence of sprinklers;

(b) In a sprinkler protected building, by means of one, or a combination of, separation distance, external walls having a fire resistance rating or other external walls of the sprinkler protected building to which are fitted external sprinklers.

NOTE – See 205.2, 205.3 and 205.4 for fire rating requirements.

205.2 Adjoining buildings

205.2.1

For the purpose of this clause, "adjoining" means to touch, or be within 1 m of, the sprinkler protected building; except that a designated historic dwelling building shall not be deemed to adjoin provided that it does not touch and the gap between the buildings is totally open to the sky.

205.2.2

The sprinkler protected building shall be separated from every adjoining building by a wall having a FRR of 120/120/120 and which extends through the roof covering for a distance of at least 450 mm and in which any openings are protected by a fire door, having a FRR of -/120/60. In the case of a building requiring a Class A water supply such fire separations shall be of concrete or masonry construction.

NOTE –

(1) Insurance interests may require a higher level of separation than nominated in this Standard.

(2) Where possible all fire doors should be fitted with draught seals.

205.3 Linked buildings

205.3.1

For the purpose of this clause, "linked" means physically connected over a distance greater than 1 m, by a passageway enclosed by two side walls and a roof, or by a conveyor (excluding a screw conveyor).

205.3.2

Either (a) – (c) or (d) shall apply:

(a) A link shall not be used for storage;

(b) A link shall not contain unprotected concealed spaces that communicate with the sprinkler protected building; and

(c) The roof of an enclosed link shall be at least 600 mm below the eaves of the adjacent unprotected building or the most remote sprinkler in the link shall be at the notional edge of the unprotected building (see figures 2.1(a) and (b)); or

(d) A specific engineering design as approved by a SSC shall be applied.

NOTE – The intention of this clause is to prevent propagation of combustible or hot gases through the link into the protected building.

205.3.3

Either (a) – (c) or (d) shall apply:

(a) The link shall be sprinkler protected for a minimum of 10 m from the notional edge of the sprinkler protected building, or the entire length, whichever is the lesser, with a discharge density commensurate with the commodity being transported through the link and the means of conveyance (e.g. forklift, conveyor) (see figures 2.1(a) and (b));

(b) Conveyors shall be interlocked to shut down on activation of the sprinkler system; and

(c) Openings from the link into the sprinkler protected building may be required, at the discretion of a SSC, to be assessed for the potential of fire spread into the protected building; or

(d) Openings from the link to the protected building shall be fitted with fire doors having a FRR not less than –/60/30 and complying with 410.

NOTE – The provisions of (c) are to cater for unprotectable openings such as may be required for conveyors and the like. The dimensions of such openings should be minimised, as reasonably practicable.

205.3.4

If the construction of the exposed wall of the sprinkler protected building is at least FRR (60)/60/60 (from the exposed side) extending at least 10 m from the link then external sprinkler protection is not required.

The pressure and flow requirements of the sprinkler system shall meet the concurrent demand of the link and the sprinkler demand immediately adjacent to the link.

205.3.5

If the exterior surface of the exposed wall of the sprinkler protected building is a noncombustible cladding extending at least 10 m from the link then the criteria of 205.3.3 shall be met and external sprinklers shall be installed on the exterior of the sprinkler protected building above, and extending 5 m beyond, the link in accordance with 517.

The pressure and flow requirements of the sprinkler system shall meet the link demand and the most onerous of either the external drencher demand or the internal sprinkler demand immediately adjacent to the link.

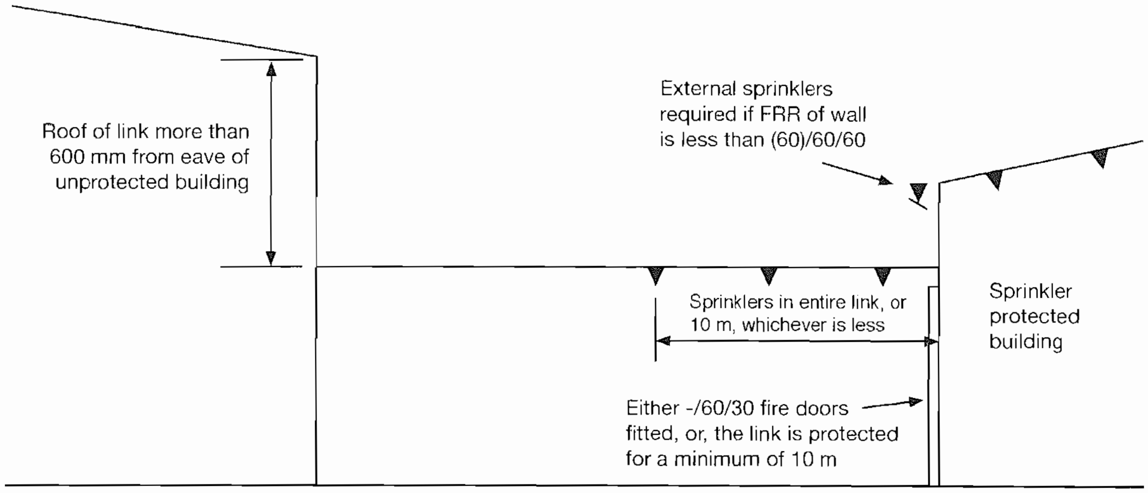

Roof of link more than 600 mm from eave of unprotected building
External sprinklers required if FRR of wall is less than (60)/60/60
Sprinklers in entire link, or 10 m, whichever is less
Sprinkler protected building
Either -/60/30 fire doors fitted, or, the link is protected for a minimum of 10 m

Figure 2.1(a) – Link to unprotected building with eave height 600 mm or greater

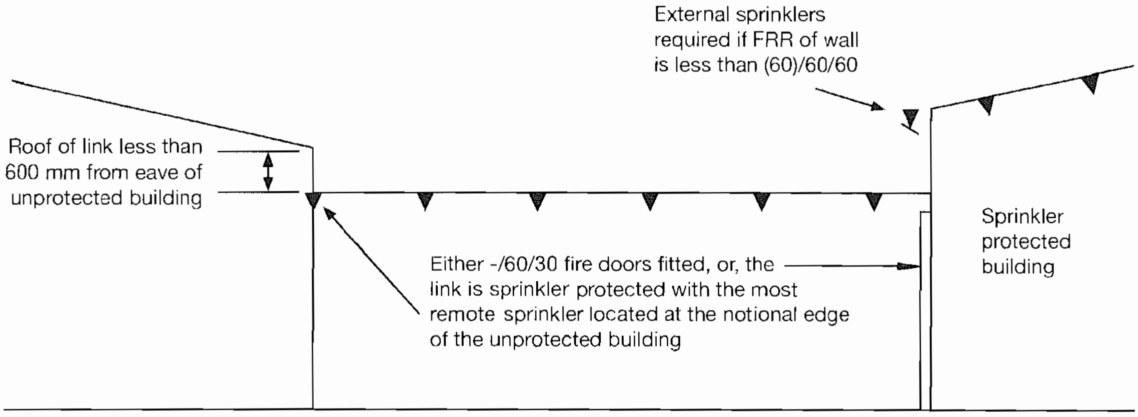

External sprinklers required if FRR of wall is less than (60)/60/60
Roof of link less than 600 mm from eave of unprotected building
Either -/60/30 fire doors fitted, or, the link is sprinkler protected with the most remote sprinkler located at the notional edge of the unprotected building
Sprinkler protected building

Figure 2.1(b) – Link to unprotected building with eave height less than 600 mm

205.3.6

If the exterior surface of the exposed wall of the sprinkler protected building is a combustible cladding within 10 m of the link then that portion of the link within 1 m of the exposed wall of the sprinkler protected building shall be considered as an adjoining building, and that section of the link between 1 m and 10 m of the exposed wall of the sprinkler protected building shall be considered as an adjacent building.

The pressure and flow requirements of the sprinkler system shall meet the link demand and the most onerous of either the external drencher demand or the internal sprinkler demand immediately adjacent to the link.

205.4 Adjacent buildings

205.4.1

For the purpose of this clause, "adjacent" means within 10 m of the sprinkler protected building but not adjoining (see 205.2) or linked to it (see 205.3).

205.4.2

The sprinkler protected building shall be separated from adjacent buildings by external sprinklers unless one of the following criteria is satisfied:

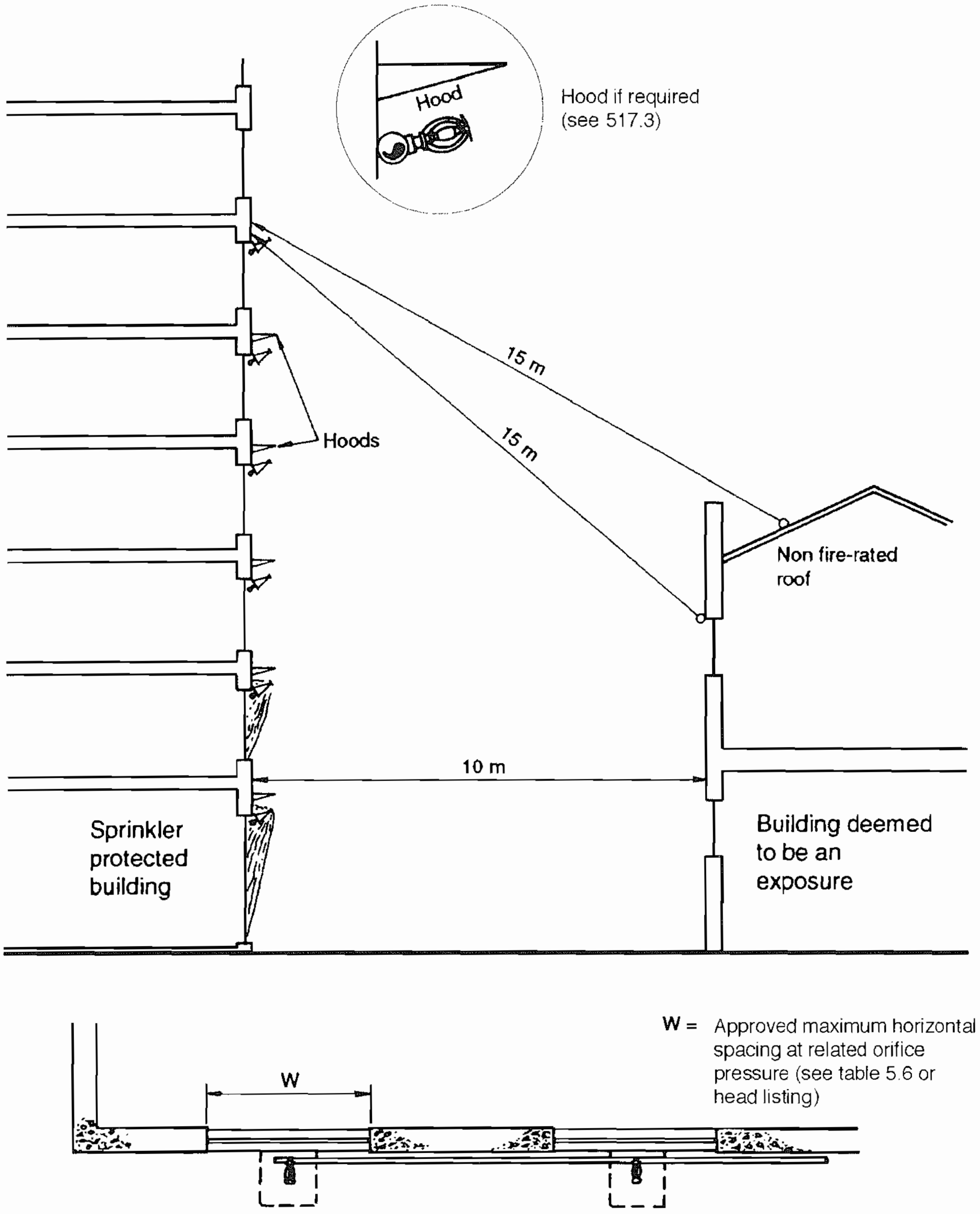
(a) The adjacent building is deemed by a SSC, in accordance with 205.4.4, not to present an exposure hazard;

(b) The external walls of the sprinkler protected building, within the range of the following described arcs, are noncombustible and have a minimum FRR of -/30/30:

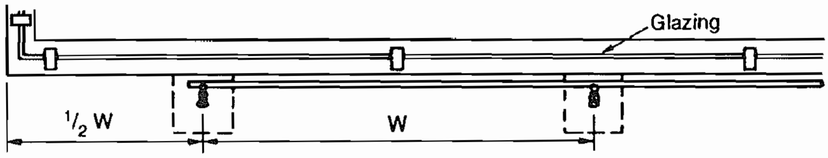
  (i) Horizontal arcs of 10 m radius from the extremities of the plan area of the adjacent building
  (ii) Vertical arcs of 15 m radius from the highest openings or from the point on the roof of the adjacent building if the roof is not of a construction having a FRR of 30/30/-
  (iii) Horizontal arcs of 10 m radius from the top of any wall on the face of the adjacent building.

  Any glazing within these arcs shall be either protected by external sprinklers or have FRR of -/30/30 (see figure 2.2); or

(c) The adjacent building is a domestic residence, domestic garage or outbuilding and is more than 3 m distant.


Hood
Hood if required
(see 517.3)
15 m
15 m
Hoods
Non fire-rated roof
10 m
Sprinkler protected building
Building deemed to be an exposure
W = Approved maximum horizontal spacing at related orifice pressure (see table 5.6 or head listing)
W

Plan view (individual windows)



Plan view (continuous windows)

Figure 2.2 – Typical external sprinklers

205.4.3

External sprinklers shall be arranged to wet those doors, windows and non-masonry portions (with a FRR of less than -/30/30) of the external walls of the sprinkler protected building within the above arcs and shall comply with 206 and 517.

205.4.4

A SSC may deem an adjacent building not to present an exposure hazard in any of the following circumstances:

(a) The adjacent building is less than 150 m^3 and the face of the sprinkler protected building within 10 m is clad in noncombustible materials and has no openings through which fire could enter;

(b) Both the sprinkler protected building and the adjacent building have been constructed in accordance with either the New Zealand Building Code or NZS 1900 Part 5;

NOTE –

(1) Buildings on the same title may present an exposure hazard even though they comply with NZS 1900 Part 5.

(2) "Constructed in accordance with NZS 1900 Part 5" should not be interpreted to automatically include any building for which a dispensation from the detailed requirements of that Standard has been granted by the territorial authority (TA).

(c) The adjacent building is itself protected by an approved sprinkler system. A SSC, before granting relief under this subclause may require proof of approval of the system in the adjacent building and may, in the event that such approval lapses, withdraw approval of the protected building until such time as external protection is provided.

NOTE – It is recommended that the attention of the owner of the protected building be drawn to this provision.

205.5 Accumulation of combustibles adjacent to protected building prohibited

Where isolated combustible fire loads require the provision of external sprinklers, protection may be provided by a sprinkler, or number of sprinklers, installed so to control the expected fire.

NOTE – This clause is expected to apply to fire loads so as rubbish skips and the like, installed adjacent to a building.

206 WATER SUPPLY REQUIREMENTS FOR EXTERNAL SPRINKLERS AND INTERNAL DRENCHERS

206.1 Design number

206.1.1

The design number of external sprinklers is that number of sprinklers which a SSC deems may operate simultaneously.

NOTE – Risk management review may necessitate additional protection.

206.1.2

In determining the design number, the following procedures shall generally be applied:

(a) For each exposure (i.e. adjacent building or accumulation of combustibles) identify the probable maximum area of fire spread. For example, if the exposure is an uncompartmented warehouse, the maximum area would be the entire area of the warehouse;

(b) Describe arcs in the manner described in 205.4.2(b) and (c);

(c) The sum of the sprinklers within those arcs is the design number.

206.2 Water supply

206.2.1

The water supply requirement for the external sprinklers shall be the flow and pressure required at the control valves to adequately supply the hydraulically worst placed design number of external sprinklers operating simultaneously.

206.2.2

The requisite water application rate is specified in 517.

206.3 Internal drenchers

Where internal drenchers are installed as part of a fire engineering design, their design flow shall be determined by simultaneously operating the number of drenchers and sprinkler heads bounded by the sprinkler system area of operation as if it were positioned adjacent to the wall(s) with internal drenchers.

NOTE – This Standard is not intended to provide guidance on the installation and design of internal drencher systems. This clause has been included in the Standard to ensure that sprinkler system operation is not compromised by the addition of internal drenchers, typically used to enhance the fire rating performance of elements of building construction, which exceed the requirement of the sprinkler Standard.

207 PERMITTED EXCEPTIONS FROM SPRINKLERING

The following are permitted exceptions to the requirements of 204 that a sprinkler protected building or sprinkler protected firecell be sprinklered throughout (see also figure 2.3 and see 212 for plastic panel construction):

(a) Concealed spaces between ceilings and roofs (including those at the apexes and sides of buildings) where the following criteria are met:

  (i) The space is subdivided by fire separations having a FRR of -/30/30 at not more than 225 m^2 and no dimension exceeding 20 m, AND

  (ii) The distance from the underside of the roof sheathing to the top of the ceiling lining does not exceed 0.8 m;

  NOTE – Spaces containing bundled cables should be sprinker protected.

(b) Concealed spaces between ceilings and floors above where the following criteria are met:

  (i) The space is subdivided by fire separations having a FRR of -/30/30 at not more than 225 m^2 and no dimension exceeding 20 m, AND EITHER

  (ii) The distance from the underside of the floor to the top of the ceiling lining does not exceed 0.8 m, OR

  (iii) The space has all its bounding surfaces wholly formed of noncombustible materials and contains no combustibles other than individual electric cables;

  NOTE – Spaces containing bundled cables should be sprinker protected.

(c) Concealed spaces between the ground and the floor immediately above where either of the following criteria is met:

  (i) The floor is of concrete and any openings are protected by fire separations having a FRR of -/30/30 and the space is not used for storage, OR

  (ii) The floor is other than concrete and of tight construction and the space is not accessible for storage purposes or entrance of unauthorised persons, contains no equipment which could be a source of ignition and is protected from the accumulation of debris. In such cases, flammable liquids are not permitted to be stored on the floor above;

  NOTE – Spaces containing bundled cables should be sprinker protected.

(d) Concealed spaces between structural floors and functional floors raised above them when all the following criteria are met:

  (i) The space does not contain any sources of ignition or combustion (excluding non-bundled electrical power or lighting wiring)

  (ii) The floor is of tight construction and the space is not accessible for storage purposes or entrance of unauthorised persons

  (iii) The space is subdivided by fire separations having a FRR of -/30/30 at not more than 225 m^2 and no dimension exceeding 20 m

  (iv) The distance from the underside of the functional floor to the top of the structural floor does not exceed 0.8 m

  (v) The space is not used as an air-conditioning or ventilation plenum, AND

  (vi) The space is not constructed of, nor contains exposed foamed plastics.

  NOTE –

  (1) While some minor quantities of combustible material such as power, lighting or data or communication cable may be present in such a concealed floor space, it should not be construed as requiring sprinkler protection. There is no defined limit to the quantities of such wiring that may be present before sprinkler protection is required. If bundles of non-fire-resistant cables are present, the space should be treated as having a combustible content and should be protected accordingly.

  (2) Spaces containing bundled cables should be sprinker protected.

  (vii) Not withstanding (i) to (vi) above it shall not be necessary to install sprinklers in the void between the structural floor and functional floor provided the height of the void does not exceed 150 mm, if the void is filled with sand or a preventative measure as approved by a SSC;

(e) With respect to special cases where localised combustibles exist in a concealed space as defined in 207(b) to (d), which would otherwise not require the space to be protected, such combustibles may be protected with localised sprinklers;

NOTE – This clause is intended to allow localised protection of areas with small fire loads, such as electric motors contained within air handling plant and the like.

(f) Staircases forming a vertical safe path enclosed by fire separations having a FRR of –/60/60 in which:

  (i) The stair is either bare concrete or steel and there is no carpet, vinyl, rubber tread (with the exception of nosing strips on the edge of each step), or other floor coverings, AND

  (ii) There is no lining or fitting within the stair enclosure which will ignite, other than light fittings, doors or bannister rail, AND

  (iii) No material is stored either permanently or temporarily, AND

  (iv) There is a sprinkler at the head of the stair, over every floor landing, and beneath any flight which intersects with a floor and forms a semi-enclosed space in which material could be stored without blocking the stair;

(g) Inside noncombustible silos or bins for the storage of grain which are within buildings forming a part of a corn mill, distillery, maltings or oil mill premises;

(h) Those ovens, hovels and kilns which are in potteries or in earthenware, brick, tile and glass works;

(i) Over salt baths and metal melt pans where the application of water would endanger persons. Pipework and sprinklers may be located over such places if a suitable canopy is fitted;

(j) The undersides of screens or shields erected over the wet end of paper-making machines.

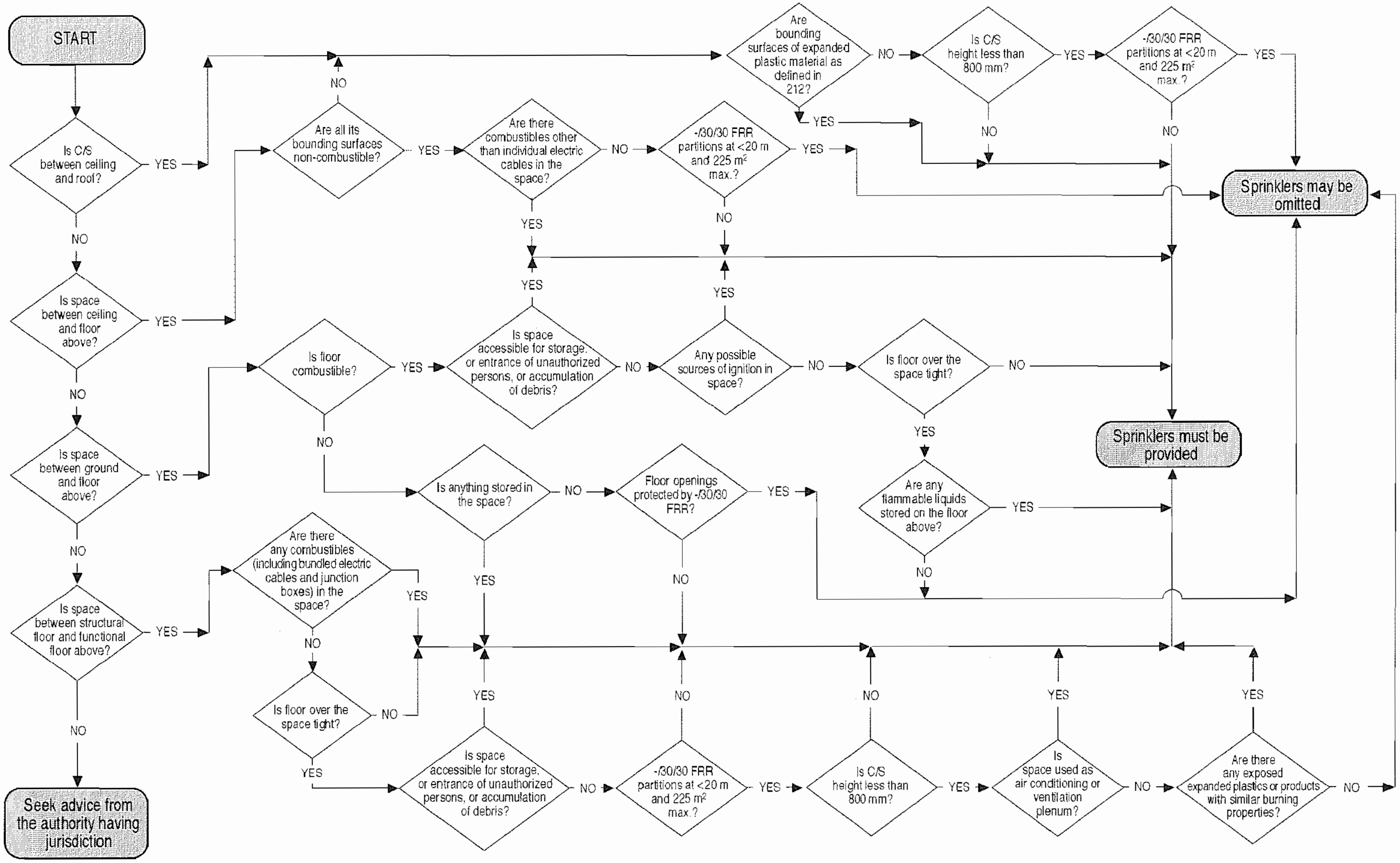

START
Is C/S between ceiling and roof?
Is space between ceiling and floor above?
Is space between ground and floor above?
Is space between structural floor and functional floor above?
Seek advice from the authority having jurisdiction
Are all its bounding surfaces non-combustible?
Are there combustibles other than individual electric cables in the space?
-/30/30 FRR partitions at <20 m and 225 m² max.?
Are bounding surfaces of expanded plastic material as defined in 212?
Is C/S height less than 800 mm?
-/30/30 FRR partitions at <20 m and 225 m² max.?
Sprinklers may be omitted
Is floor combustible?
Is space accessible for storage, or entrance of unauthorized persons, or accumulation of debris?
Any possible sources of ignition in space?
Is floor over the space tight?
Are any flammable liquids stored on the floor above?
Sprinklers must be provided
Is anything stored in the space?
Floor openings protected by -/30/30 FRR?
Are there any combustibles (including bundled electric cables and junction boxes) in the space?
Is floor over the space tight?
Is space accessible for storage, or entrance of unauthorized persons, or accumulation of debris?
-/30/30 FRR partitions at <20 m and 225 m² max.?
Is C/S height less than 800 mm?
Is space used as air conditioning or ventilation plenum?
Are there any exposed expanded plastics or products with similar burning properties?
YES
NO

Figure 2.3 – Permitted exceptions from sprinklering of concealed spaces

208 PROVISION OF HAND OPERATED FIREFIGHTING APPLIANCES

208.1

Throughout the occupiable area of a sprinkler protected building or sprinkler protected firecell, hand operated firefighting equipment shall be provided to the requirements of NZS 4503.

NOTE –

(1) This clause is not a requirement for a sprinkler system to comply with the Compliance Documents of the New Zealand Building Code.

(2) Hand operated firefighting appliances are a necessary adjunct to sprinkler protection. Their main use is in the extinguishment of fires in the incipient stages before the sprinklers are brought into operation and also for final extinguishment of the small remnants of combustion which may not have been completely extinguished following the operation of the sprinklers.

208.2

Extra high hazard storage risks shall be provided with a minimum of 25 mm hose instead of other options allowed by NZS 4503.

NOTE –

(1) Although conventional hose reels are unlikely to be effective in the circumstances described in 208.2, the Department of Building and Housing considers that the requirements of 208.2 impose a requirement higher than that set out in the Compliance Documents of the New Zealand Building Code at the time of publication of this Standard.

(2) This clause is not a requirement for a sprinkler system to comply with the Compliance Documents of the New Zealand Building Code.

208.3

Hose assemblies and associated pipework shall conform to the following:

(a) Hose assemblies installed to comply with 208.2 shall meet the requirements of AS/NZS 1221. A valved gauge connection shall be provided adjacent to the two most hydraulically remote hose reels;

(b) Pipework supplying 25 mm hose reels shall be designed to allow a minimum of 100 L/min to simultaneously discharge from each of the two hydraulically most remote hose reels, with a pressure of at least 450 kPa available at the hose reel valve;

(c) All other installation criteria shall comply with NZS 4503.

NOTE – This clause is not a requirement for a sprinkler system to comply with the Compliance Documents of the New Zealand Building Code.

209 PROVISION OF BLOCK PLAN

A block plan of the buildings, including the adjacent buildings, protected by the sprinkler system shall be located in a position immediately adjacent to the control valves. This plan shall be oriented according to the viewing position and shall provide the following information:

(a) Location of the control valves and fire service inlets;

(b) A diagram of the water reticulation network with connections to the street main or site fire main;

(c) A north point;

(d) Any external sprinklers;

(e) The highest design pressure and flow;

(f) The hazard classification of each protected area and, in the case of extra high hazard, the design density and assumed area of operation;

(g) The location of any area specially protected in accordance with 907.7 for storage of aerosols. The level of aerosol (2 or 3) permitted shall be shown;

(h) Fire separations, fire doors and self-closing doors required by this Standard;

(i) The area protected by each installation;

(j) Location of any drain valves;

(k) Scale;

(l) Location of tail-end valve sets and other subsidiary stop valves;

(m) Location of any industrial, domestic or other approved take offs and their associated isolation valves;

(n) The block plan shall generally identify the types of sprinklers used in the installation, to allow the correct types of sprinklers to be used for service work or for installations. The form of this information is shown in table 2.4.

Table 2.4 – Block plan sprinkler information

Location	**Head manufacturer**	**Model**	**SIN number**	***K* Factor**	**Maximum area per head(*)**	**Minimum orifice pressure(*)**

* These columns relate to the specific installation and are not to be the generic capabilities of the Sprinkler Head in question.

(o) The block plan shall be updated as necessary following any extensions or alterations to the system;

(p) When the valve controlling the sprinkler system water supplies is buried, in a toby box or valve pit, the diagram of the water supplies in (b) shall include sufficient dimensions to allow the street valve to be located if the valve is obscured during road resealing or similar events.

210 PROVISION OF WATER SUPPLY REFERENCE INFORMATION

210.1

To facilitate routine checking “water supply reference information” for each water supply shall be displayed in an indelible form at the control valves, generally in the manner shown in figure 2.4.

210.2

In the case of a new system, the reference pressures shall be established at the time of final inspection of the sprinkler system and agreed with a SSC. In the case of an existing system, they shall be established in the course of a routine inspection (see 1203) and shall be agreed with a SSC.

210.3

The reference pressures shall be as follows:

(a) The design pressure for each area of the protected building;

(b) The pressure shown on the installation gauge when each water supply is discharging separately through the fully open installation drain valve;

(c) The pressure shown on the installation gauge when the design flow is passed through the alarm valves from each water supply;

(d) The pump pressure with the pump bypass fully open;

(e) Pressure control valve set pressures (such as relief or reducing valves);

(f) Pressure switch set pressure.

Reference pressures shall be tabulated for all gauges, listing the range of expected gauge pressures, and what action is required if the measured pressure falls outside acceptable levels.

This information shall be provided in the form of gauge schedules, which shall be located as follows:

(a) Valve room – all sprinkler control valve gauge information;

(b) Pump room – all pump room gauge information;

(c) Tail-end valve sets – all tail-end valve set gauge information.

Where such locations are co-located, the gauge schedules may be combined in a single document.

An indicative reference pressure schedule is shown in table 2.5.

210.4

A water supply reference graph on $Q^{1.85}$ abscissa graph paper shall be mounted adjacent to the block plan with the following information plotted on it:

(a) Each agreed design pressure at design flow;

(b) Each water supply characteristic curve as measured at the time of final inspection of the system by a SSC;

(c) The installation drain friction loss curve;

(d) If system is a boosted town's main the unboosted town's main curve shall also be plotted.

See example in figure 2.4.

Table 2.5 – Typical reference pressure schedule

Agreed hydraulic requirements

For the most demanding	**Design flow** (L/min)	**Design pressure** (kPa)
ELH area of operation	375	675
OH 3 area of operation	1120	410
EHH area of operation	2050	675

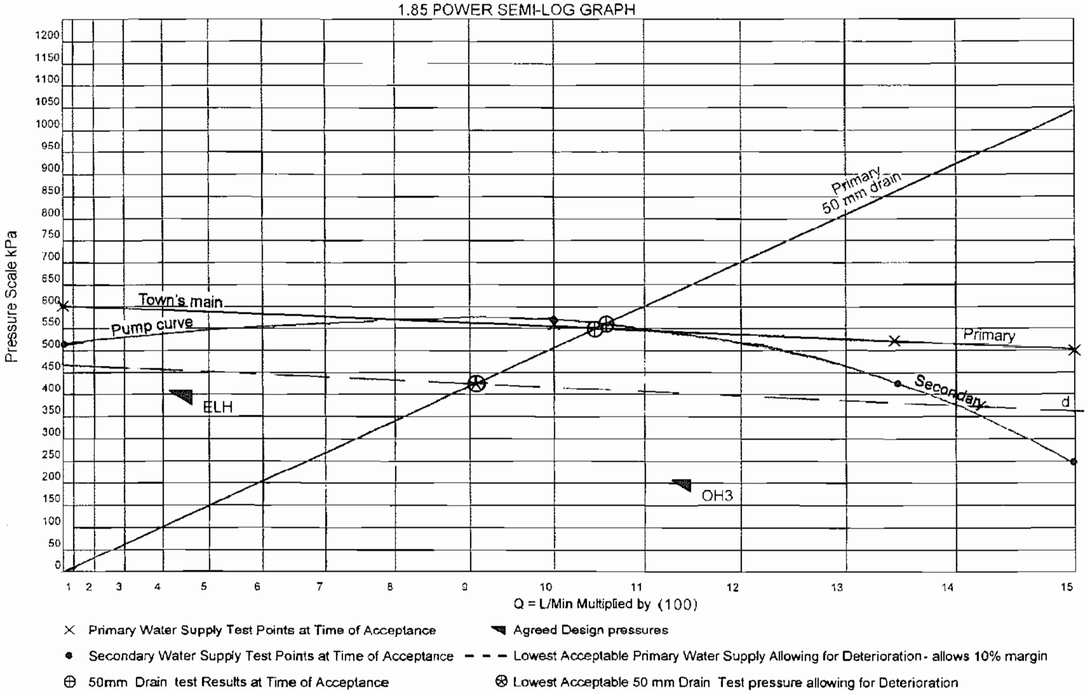
Reference pressures

Item	**Normal pressure**	**Comments**
Standing pressure	1150 – 1200 kPa	
Defect pressure	1000 kPa	
Fire pressure	850 kPa	
Electric pump start	750 kPa	
Town's main static pressure	550 – 600 kPa	Report if less than 460 kPa
Electric test by pass pressure	400 kPa	Report if less than 300 kPa
Town's main 50 mm drain test	550 kPa	Report if less than 430 kPa
A1 Pump test return pressure	560 kPa	Report if less than 430 kPa
Tail-end pre-action system diaphragm pressure	1150 – 1200 kPa	
Tail-end pre-action system Pilot line air pressure	300kPa –350 kPa	
Tail-end pre-action system Pilot line low air pressure alarm	175 kPa	
Tail-end pre-action system Supervisory pressure	50 kPa – 85 kPa	
Tail-end pre-action system Supervisory pressure alarm	30 kPa – 40 kPa	

System... Approval Date..............................

HYDRAULIC REFERENCE PRESSURE MEASURED AND ACCEPTED ON APPROVAL DATE

Supply	Flow (L/min)	Installation gauge pressure (kPa)	Supply gauge pressure (kPa)	Suction or other gauge pressure (kPa)
Primary	0	600	610	-
	1000	560	570	-
	1350	520	540	-
	1500	500	510	-
	Drain fully open	550	560	
Secondary	0	510	510	70
	1000	565	565	60
	1350	430	430	60
	1500	250	250	60
	Drain fully open	560	560	50



Note - To Establish the Drain Valve Test Curve

(a) Mark the point of intersection on the graphed water supply curve of the installation pressure when the water supply is discharging through the fully open drain valve.

(b) Draw a line from zero through the point of intersection. THIS IS THE DRAIN TEST CURVE.

(c) If there is a second supply repeat the procedure of (a) with the second supply discharging. The intersect point should be on or close to the test curve of (b).

Figure 2.4 – Display of water supply reference information

211 MULTI-STOREYED BUILDINGS

211.1

Multi-storeyed buildings having more than six floors shall have subsidiary stop valves provided at each floor to permit isolation of individual floors, or sections thereof, for service work. Multi-storeyed buildings of fewer floors may also have such valves. Levels below ground are to be included in the floor number.

211.2

All such valves shall be supervised against interference and shall comply with the requirements of 404.2.4 and 404.2.5.

211.3

Multi-storey buildings may be fitted with an enhanced safety valve set complying with 405.

211.4

In buildings of such height that the requirements of 401.2 and 407.2.1 mean that the fire brigade alarm and control valves cannot, as a consequence of static head, be located at street level, alarm valves may, with approval be located in an approved position at upper levels of the building.

211.5

Multi-storey buildings, having more than six floors, shall be fitted with flow switches to indicate the floor on which the sprinkler system has operated. The indication shall be provided on a fire indication panel complying with NZS 4512 in a location approved by the New Zealand Fire Service. Multi-storeyed buildings of fewer floors may also have flow switches.

NOTE – The number of floors includes the ground floor and any basements or levels below ground.

212 BUILDINGS CONSTRUCTED WITH EXPANDED PLASTIC CORED INSULATED PANELS

212.1

The requirements in table 2.6 apply to foamed plastic cored insulated panels that have not been tested and approved by an accredited laboratory in accordance with ISO 9705, FM Approval Standard 4880 or LPCB LPS 1181 Part 1, Part 2 or LPCB LPS 1208.

The ELH and OH1, 2 and 3 values in table 2.6 are at variance from the fully highly protected risk requirements in FM Global Data Sheet 1-57. These revisions have been made with due regard to the lower requirements and fire loading found in New Zealand. If there are higher fire loads adjacent to the panels then higher discharge densities shall be used.

Further information (normative) on design requirements for buildings constructed with Foam Plastic Cored Insulated Panels is contained in Appendix J.

When tested in accordance with ISO 9705, an assembly which has achieved all of the following criteria shall not be required to comply with table 2.6:

(a) Not support a self-propagating fire which extends to the outer extremities of the test area within the 20 minute test as evidenced by flaming or material damage when the lining is removed (including melting or charring of core materials);

(b) Not reach flashover (total heat release of 1000 kW) when exposed to 100 kW for 600 seconds followed by exposure to 300 kW for 600 seconds;

(c) Have a smoke growth rate index ($SMOGRA_{RC}$) not more than 100; and

(d) Sustain the applied load, if any, for the duration of the test period.

NOTE – See Appendix J for a definition of $SMOGRA_{RC}$.

Table 2.6 – Design data for protection of expanded plastic cored panels

Occupancy fire hazard category/area	Panel thickness	Discharge density	Area of operation	Additional sprinkler requirements
ELH	Any	5 mm/min	162 m^2	68 °C QR sprinklers
OH1 & OH2	Any	8 mm/min	186 m^2	–
OH3 with no storage exceeding 20 m^2	Any	8 mm/min	186 m^2	–
OH3 with storage exceeding 20 m^2 and all other occupancies Either (a), or	Any	8 mm/min minimum up to 12 mm/min as required by storage height	186 m^2	Provide perimeter sprinklers (see 212.2 and 212.3 for specific requirements)
(b)	<75 mm	12 mm/min	186 m^2	–
	75 mm to 100 mm	15 mm/min	186 m^2	–
	>100 mm	18 mm/min	186 m^2	–
Concealed spaces with expanded plastic cored panels used for floors only, with walls and ceilings of noncombustible construction and no combustible contents including cabling, ductwork or plant	Any	5 mm/min	54 m^2 (minimum of 6 sprinklers)	68 °C QR sprinklers
All other concealed spaces	Any	8 mm/min	186 m^2	–

NOTE –

(1) Limited to panel heights of 9 m.

(2) Additional requirement for dry pipe systems – see 212.3.

(3) It is not practical to separate out life safety and property protection issues surrounding panel protection. The criteria presented represent a practical assessment of the levels of protection considered to be effective for most situations where insulated panel is installed.

(4) Concealed spaces in this clause shall be considered areas of buildings between the uppermost ceiling space and underside of the roof, which have controlled access and can not be used for either storage or locations for plant.

(5) Any spaces between the ceilings and underside of roof which is used for the storage of combustible materials, or is used as a machinery space for hydraulically powered plant, electrically powered plant, or any high voltage cabling that will substantially increase the fire loading shall be treated as an occupied space and protected to the occupancy fire hazard category risk.

(6) Table 2.6 does not preclude the use of alternative solutions with the approval of a SSC.

212.2 Wet pipe systems

Where perimeter sprinklers are required for wet pipe systems they shall be installed to the following details:

(a) The water demand for these heads shall be added to the ceiling sprinkler demand;

(b) There shall be a row of sprinklers 600 mm (+ or – 50 mm) from any panel wall. Starting with the first head of each row 600 mm from each corner;

(c) Maximum spacing along the wall of 3.0 m;

(d) The minimum flow from the sprinkler adjacent to the wall shall be 115 L/min;

(e) The sprinkler shall be quick response, 68 °C (or 30 °C above the highest ambient temperature);

(f) Minimum of 10 wall heads discharging in addition to roof level demands;

(g) Ceiling sprinklers shall be positioned so that they are at staggered intervals to the perimeter sprinklers and shall be positioned to provide the normal minimum clearance spacing – see Part 5.

NOTE – Where these perimeter sprinklers are being retrofitted to existing installations due regards should be had to existing ceiling sprinkler spacing. Existing sprinkler heads may need to be moved or perimeter heads shielded to prevent wetting of adjacent sprinklers.

212.3 Dry pipe systems

Where perimeter sprinklers are required for extra high hazard dry pipe systems they shall be installed to the following details:

(a) The water demand for these heads shall be added to the ceiling sprinkler demand;

(b) There shall be a row of sprinklers 600 mm (+ or – 50 mm) from any panel wall, starting with the first head of each row 600 mm from each corner;

(c) Maximum spacing along the wall of 3.0 m;

(d) The minimum flow from any sprinkler adjacent to the wall shall be 115 L/min;

(e) The sprinkler shall be quick response, 68 °C (or 30 °C above the highest ambient temperature);

(f) Minimum of 14 perimeter wall heads operating at 115 L/min each;

(g) Ceiling sprinklers shall be positioned so that they are at staggered intervals to the perimeter sprinklers and shall be positioned to provide the normal minimum clearance spacing – see Part 5.

(h) Water shall be available at the most remote head within 30 seconds.

NOTE – Where these perimeter sprinklers are being retrofitted to existing installations due regard should be had to existing ceiling sprinkler spacing. Existing sprinkler heads or the perimeter heads may need to be moved to prevent shadowing.

212.4 Ceiling heights exceeding 9.0 m

If ceiling heights exceed 9.0 m any proposals for sprinkler protection shall be subject to consultation with a SSC for a specific system design and approval.

212.5 Alternative panel materials and suitable methods of sprinkler protection

212.5.1

Where other foamed plastic materials or alternative core materials are used in insulated panels the proposed methods of protection shall be submitted to a SSC for determination.

212.5.2

In considering if the combustibility or fire ratings of other foamed plastic materials used in insulated panel construction requires additional sprinkler protection measures, a SSC will consider any full scale test results from a reputable accredited fire test laboratory that can provide listed ratings and similar fire performance certificates.

Part 3
TYPES OF INSTALLATIONS

301 GENERAL

The types of installation covered by this Standard are:

(a) Conventional sprinkler installations designed on:

  (i) Wet pipe installation (302.1)
  (ii) Dry pipe installation (302.2)
  (iii) Tail-end dry pipe installation (302.3)
  (iv) Pre-action installation (302.4)
  (v) Antifreeze installation (302.5)
  (vi) Tail-end antifreeze (302.6);

NOTE – In relatively small areas involving flammable liquid hazards conventional sprinkler installations may incorporate subsidiary special protection in the form of medium or high velocity sprayers.

(b) Deluge installations (using open sprinklers and medium or high velocity sprayers (303)).

302 CONVENTIONAL SPRINKLER INSTALLATIONS

302.1 Wet pipe installation

302.1.1

A wet pipe installation is a sprinkler installation permanently charged with water both above and below the installation alarm (wet pipe) valve.

302.1.2

Wet pipe installations shall be used whenever ambient temperatures remain at 4 °C or above unless otherwise permitted or required by the Standard. Wet pipe installations shall not be used if continuous ambient temperatures are below this limit. The use of wet pipe installations in areas subject to intermittent ambient temperatures, at or below this limit, shall be permitted only if the consequences of exposure to these temperatures have been considered and adequate protection measures taken (see Appendix G). Such protection measures shall be agreed with a Sprinkler System Certifier (SSC), taking into account the probability and consequences of freezing balanced with reduced reliability of other than wet pipe systems.

NOTE – Within a coolstore, with average ambient temperature of 4 °C or above, there may be both excessively low or very high temperatures as a result of cold air from cooling coils or radiant or convective heat from defrost devices (either in normal mode or testing mode). In areas of such stores where such low temperatures could occur, one of the technologies allowed for in this Standard for dealing with below 4 °C situations (e.g. dry drop or antifreeze tail-end or a tail-end dry pipe installation) should be used. Sprinklers likely to be subject to short term high temperatures should be of a sufficient temperature rating having regard to the temperature distribution and the location of sprinklers.

302.1.3

Sprinklers in wet pipe installations may be installed in either the upright or pendent position.

302.1.4

Except as allowed by 302.1.5, wet pipe installations shall be so designed that the total floor area protected, excluding concealed spaces, controlled by one set of valves does not exceed 11,000 m^2.

302.1.5

If the building is a multi-storeyed building, fitted with subsidiary stop valves to permit isolation of individual floors or sections (see 211), and an enhanced safety valve set, in compliance with 405 and figure 4.5, then the floor area protected by any wet pipe installation is unlimited, subject to the following additional requirements:

(a) The floor area served by any subsidiary stop valve does not exceed 11,000 m^2;

(b) Flow switches are installed with a test drain to simulate the discharge of one sprinkler head. This test drain may be a bypass around the drain referred to in (c) below. The flow switch shall not generate a fire call. Subsidiary stop valves with supervisory devices shall be installed in accordance with 404.2.4 and 404.2.5. The flow switches shall indicate, at the Fire Service attendance point, the floor on which any sprinkler has operated;

(c) A drain valve of at least one-third the distribution pipe diameter, but in no case less than 25 mm Nominal Bore shall be installed downstream of each subsidiary stop valve and connected to a permanently piped drain (which is drained to the appropriate public utility installation);

(d) The subsidiary stop valves shall be located in stair wells, clearly labelled and accessible from floor level by the Fire Service and service personnel, as noted in 404.2.4.

302.2 Dry pipe installation

302.2.1

A dry pipe installation is a standard sprinkler installation in which the installation pipework is permanently charged with gas under pressure above the alarm (dry pipe) valve and with water under pressure below the valve. When a sprinkler head opens, the gas pressure drops thus allowing the dry pipe valve to open and admit water to the installation. To speed up the opening of the valve an accelerator or exhauster may be included in the installation.

302.2.2

Dry pipe installations are normally allowed only in buildings where the temperature conditions are demonstrated to be below freezing such as climatic conditions, or as in cold or cool stores, fur vaults and the like or where the temperature is maintained above 70 °C as in drying ovens and the like. Special approval is required for dry pipe installations in other circumstances.

302.2.3

Unless the provisions of 302.2.4 are met, dry pipe installations shall be so designed so that the volume of pipework controlled by one set of valves, including tail-end extensions does not exceed 1,900 litres, or 2,800 litres if the installation is fitted with a listed Quick Opening Device, such as an accelerator or an exhauster (see 404.5.1).

NOTE – The volumes above may be increased by 50 % provided an automatic fire alarm system complying with NZS 4512 (and having declared functional requirements in accordance with items (a), (b) and (e) of 105 of that Standard) is installed in the same area as the sprinklers and arranged to open the dry pipe alarm valve prior to the activation of a sprinkler head. Failure of the detector system should not inhibit the normal activation of the installation.

302.2.4

The volume of pipework controlled by any dry installation may be unlimited, if it can be demonstrated that, with the installation in its dry mode, water is available at the most remote head within 60 seconds of sprinkler activation by one of the methods specified in 305.

302.2.5

Sprinklers shall be installed in the upright position above the line of pipes in dry pipe installations. An exception to this rule is allowed if listed dry pendent or dry sidewall pattern sprinklers are installed and no residual water can pond in any section of a drop.

302.2.6

Pipework shall be arranged with adequate slope for drainage as described in 403.11.

302.2.7

Where dry pipe installations are expected to be subject to continuous freezing conditions, the pressurising gas shall have a dew point at its appropriate pressure below the expected temperature.

302.2.8

Dry pipe installations shall not use gridded pipework arrays.

302.2.9

Dry pipe alarm valves shall comply with the requirements of 404.4.2.

302.2.10

The area served by a dry pipe installation valve set shall not exceed 11,000 m^2.

302.2.11

There are restrictions and special requirements on the use of dry pipe installations in extra high hazard storage situations (see 903).

302.2.12

The design of dry pipe installations in freezers or cold stores shall provide the ability to dismantle the system for removal of ice plugs, and to be able to inspect all main runs by provision of inspection tees or short easily removable sections of pipe. Extension of the main runs to outside the low temperature room, with straight line of sight, allows for visual inspection and lancing of ice plugs.

302.3 Tail-end dry pipe installations

302.3.1

These installations are essentially similar to dry pipe installations except that they are of comparatively small extent and form extensions to standard sprinkler installations.

302.3.2

They are permitted:

(a) As extensions to a wet pipe installation in comparatively small areas where there is the possibility of frost damage in an otherwise adequately heated building;

(b) As extensions to a wet pipe installation in cold stores and high temperature ovens or stoves, when the tail-end installations would be on the dry pipe principle.

302.3.3

Sprinklers in tail-end dry pipe installations shall be installed in the upright position above the line of pipes and pipework shall be arranged with adequate slope for drainage. An exception to this rule is allowed if listed dry pendent or dry sidewall pattern sprinklers are installed.

302.3.4

The total volume of the pipework controlled by any one tail-end valve set shall not exceed 1,900 litres.

302.3.5

To assist in the maintenance and testing of a tail-end dry pipe valve set supervised subsidiary stop valves in accordance with 404.2.4 and 404.2.5 shall be fitted immediately upstream and downstream of the tail-end dry pipe valves. Drain and test valves, drain pipes and pressure gauges shall be fitted both upstream and downstream, between the tail-end dry pipe valve and the respective subsidiary stop valves. The drain pipes shall discharge to a location where it will not cause damage, hygiene or safety hazards.

302.3.6

There are restrictions and special requirements on the use of dry pipe installations in extra high hazard storage situations (see 903).

302.3.7

The design of tail-end dry pipe installations in freezers or cold stores shall provide the ability to dismantle the system for removal of ice plugs, and to be able to inspect all main runs by provision of inspection tees or short easily removable sections of pipe. Extension of the main runs to outside the low temperature room, with straight line of sight, allows for visual inspection and lancing of ice plugs.

302.4 Pre-action installation

302.4.1

A pre-action installation is a form of dry pipe installation incorporating water discharge pipework fitted with closed sprinkler heads, but charged with low pressure gas for supervision purposes. Water entry to this piping installation is controlled by a further installation of small diameter piping with closed heads charged with gas for control purposes, or an approved electronic detection system (see 302.4.8). Before water may be discharged it is necessary that the sprinkler heads on both the discharge pipework and the detection devices (sprinklers or electronic detectors) both operate.

Pre-action installations are commonly available as single interlock and double interlock designs.

Single interlock installations admit water into the pipework on operation of the detection devices. These are the installations that are most commonly installed to protect computer suites and the like.

Double interlock installations will only admit water into the pipework upon operation of both the detection device and automatic sprinklers. Double interlock installations shall only be used for freezer fire protection, and shall not be used for protection of computer suites and the like.

NOTE – Non-interlock installations are also available and admit water into the pipework when either the detection or discharge sprinkler operates. They are not commonly installed.

302.4.2

Detection sprinkler devices shall be in the same area/zone as the discharge sprinklers and spaced at not more than 21 m^2 for ELH and OH systems, with 12 m^2 for EHH systems. Some EHH risks have specific requirements with spacing of detection devices to equal the discharge sprinkler spacing. Notwithstanding 402.4.2, the detector sprinklers may have a temperature rating of no less than 15 °C above the highest expected ambient temperature.

302.4.3

Unless the provisions of 302.2.4 are met, pre-action installations shall be so designed so that the volume of pipework controlled by one set of valves, including tail-end extensions does not exceed 1,900 litres, or 2,800 litres if the installation is fitted with a listed quick opening device. A listed quick opening device includes an accelerator or air exhauster, or a smoke detection system or heat detection system installed in compliance with NZS 4512, and having the declared functional requirements in accordance with items (a), (b) and (e) of 105 of that Standard. This detection system shall be installed in the same area as the sprinklers and arranged to open the pre-action alarm valve prior to the activation of a sprinkler head. Failure of the detection system shall not inhibit the normal activation of the installation.

302.4.4

Sprinklers shall be installed in the upright position above the line of pipes in pre-action pipe installations. An exception to this rule is allowed if listed dry pendent or dry sidewall pattern sprinklers are installed. Pipework shall be arranged with adequate slope for drainage as described in 403.11. Both the sprinkler head and any return bend assembly shall be in an area normally at +4 °C.

302.4.5

Pre-action installations shall not utilise gridded pipework arrays.

302.4.6

Where pre-action pipe installations are expected to be subject to continuous freezing conditions, the pressurising gas shall have a dew point at its appropriate pressure below the expected temperature.

302.4.7

To assist in the maintenance and testing of pre-action installations a supervised subsidiary stop valve shall be fitted immediately downstream of the pre-action valve. A drain and test valve shall be located between the pre-action valve and the downstream subsidiary stop valve to permit trip testing without flooding the installation. If a fire sprinkler inlet is attached to the installation it shall be connected to the installation upstream of the subsidiary stop valve to permit flow testing from the FSI without flooding the installation. For tail-end pre-action installations a supervised subsidiary stop valve shall also be provided immediately upstream of the pre-action valve.

Where the drain and test valve can be inadvertently left open, and thereby compromise the installation's performance, this valve shall be fitted with a listed supervisory device.

302.4.8

Full details of proposals for the installation of pre-action installations shall be submitted to a SSC before any erection work is commenced. When considering such proposals, a SSC shall normally approve installations which use pilot operated sprinklers as the primary means of detection, unless such detection is not practicable. Approved electronic based detection systems may be used in parallel with pilot sprinkler operated detection systems to speed up the release of water into the sprinkler pipework. Failure of the electronic detection system shall not inhibit the activation of the installation.

Pre-action installations in freezers, cold stores, chillers, etc may be of the Double Interlock type using approved electronic based detection systems only. These detection systems shall be installed in the same area as the sprinklers with detection devices spaced as stated in 302.4.2.

NOTE – This clause allows a SSC to approve pre-action systems that do not use pilot operated sprinkler detection systems in certain circumstances. Given that electronic detection systems are inherently less reliable than sprinkler based detection systems, such alternative systems should only be used as the primary release mechanism if pilot operated sprinklers are not a practical option. An example of such a situation is where pre-action systems are used to prevent in-rack sprinklers freezing. In such an example, a listed lineal type thermal detection system would normally be deemed as being acceptable by a SSC. Where detection systems are installed to release pre-action systems in areas such as computer suites and the like, they should only be used in parallel to pilot sprinkler operated detection release systems.

302.4.9

The design of pre-action installations in freezers or cold stores should provide the ability to dismantle the system for removal of ice plugs, and to be able to inspect all main runs by provision of inspection tees or short easily removable sections of pipe. Extension of the main runs to outside the low temperature room, with straight line of sight, allows for visual inspection and lancing of ice plugs.

302.5 Antifreeze installation

302.5.1

An antifreeze installation is defined as a conventional automatic sprinkler installation in which an entire installation is charged with an antifreeze solution and connected to one or more approved water supplies. The antifreeze solution, followed by water, discharges immediately upon actuation of the sprinkler heads. Unless specifically listed for that purpose, they shall not be used in storage occupancies.

NOTE – Most commonly used antifreeze solutions are flammable in the concentrations used for freeze protection. At the time of drafting this Standard, the committee was aware of one listed antifreeze installation, which is restricted to the protection of Class 1 and Class 2 commodities.

302.5.2

Acceptable antifreeze solutions are given in table 3.1. Where the installation is supplied by a public water connection antifreeze solutions other than aqueous solutions of pure glycerine or pure propylene glycol shall not be used. On installations incorporating CPVC pipe, only glycerine solutions shall be used.

302.5.3

An antifreeze solution shall have a freezing point at least 10 °C below the minimum expected temperature including the temperature of the incoming cold air.

302.5.4

The density shall be determined by a hydrometer of suitable scale. The density of the solution shall take into account the temperature of the fluid to ascertain the freezing point of the solution. A suitable hydrometer and thermometer shall be provided at the installation control valves.

302.5.5

Antifreeze installations shall be divided into areas with pipework subdivisions not exceeding approximately 100 heads.

NOTE – This clause is intended to limit the volume of antifreeze solution that discharges onto a fire, before water is applied to the fire.

302.5.6

This subdivision in 302.5.5 may be achieved by the use of tail-end control valves or, alternatively, check valves may be installed provided that supplementary drains are provided from the tail-end of each subdivision and the total area covered by one set of control valves does not exceed the limitations specified for wet pipe systems. Subsidiary stop valves are to be installed immediately upstream of the check valves to allow servicing and testing. See also 302.6.3.

302.5.7

An antifreeze collection reservoir constructed of material compatible with the antifreeze solution shall be provided. This reservoir shall have a capacity of not less than 1.25 times the total capacity of the pipework in the largest subdivision of the installation, plus the capacity of any antifreeze filled feed main serving that subdivision.

302.5.8

Where check valves are used to subdivide the installation, supplementary drains of at least 25 mm nominal diameter shall be provided and arranged to discharge to the antifreeze reservoir. These drains shall be individually carried to the location of the antifreeze reservoir at which location they shall be fitted with controlling stop valves and pressure gauges. Downstream of the supplementary drain valve, the drains may be manifolded to discharge into the reservoir. Provision shall also be made to divert the drain flow to waste. Where such drains are provided on an installation which is protecting refrigerated areas, traps to prevent thermo-siphoning shall be provided where the drain emerges from the refrigerated area.

302.5.9

Unless otherwise listed or approved, sprinkler heads shall be installed in the upright position and pipework shall be arranged with adequate slope for drainage (see 403.11). An exception to this rule is allowed if listed dry pendent or dry sidewall pattern sprinklers are installed. Both the sprinkler head and any return bend assembly shall be in an area normally at +4 °C.

302.5.10

An expansion chamber shall be provided downstream of any check valve forming part of the antifreeze installation, to ensure that the installation, or part thereof, is not over-pressurised by the thermal expansion of the antifreeze solution.

NOTE – A SSC may approve an alternative method of achieving this performance requirement, as part of an installation listing.

302.5.11

Clear maintenance and testing procedures shall be prepared and placed in a conspicuous position adjacent to the alarm valves and control valves.

302.5.12

The design of antifreeze installations in freezers or cold stores shall provide the ability to dismantle the system for removal of ice plugs, and to be able to inspect all main runs by provision of inspection tees or short easily removable sections of pipe. Extension of the main runs to outside the low temperature room, with straight line of sight, allows for visual inspection and lancing of ice plugs.

302.5.13

Full details of proposals for the installation of antifreeze installations shall be submitted to a SSC before any erection work is commenced.

302.6 Tail-end antifreeze installation

302.6.1

These are portions of an installation which are arranged to protect a low temperature area by means of an antifreeze solution but as an extension of the conventional wet pipe installation.

302.6.2

Antifreeze solutions shall be as given in table 3.1.

Table 3.1 – Antifreeze solutions

Material	Solution concentration	Density at 15.6°C	Freezing point (°C)	Scale
Glycerine [(1)]	50 % water (v/v) 40 % water (v/v) 30 % water (v/v)	1.133 1.151 1.165	–26.1 –30.0 –40.0	Hydrometer scale 1.000 to 1.200
Propylene glycol	70 % water (v/v) 60 % water (v/v) 50 % water (v/v) 40 % water (v/v)	1.027 1.034 1.041 1.045	–12.8 –21.1 –32.2 –51.1	Hydrometer scale 1.000 to 1.120 (Subdivisions 0.002)
Diethylene glycol	50 % water (v/v) 45 % water (v/v) 40 % water (v/v)	1.078 1.081 1.086	–25.0 –32.8 –41.1	Hydrometer scale 1.000 to 1.120 (Subdivisions 0.002)
Ethylene glycol	61 % water (v/v) 56 % water (v/v) 51 % water (v/v) 47 % water (v/v)	1.056 1.063 1.069 1.073	–23.3 –28.9 –34.4 –40.0	Hydrometer scale 1.000 to 1.120 (Subdivisions 0.002)

NOTE –

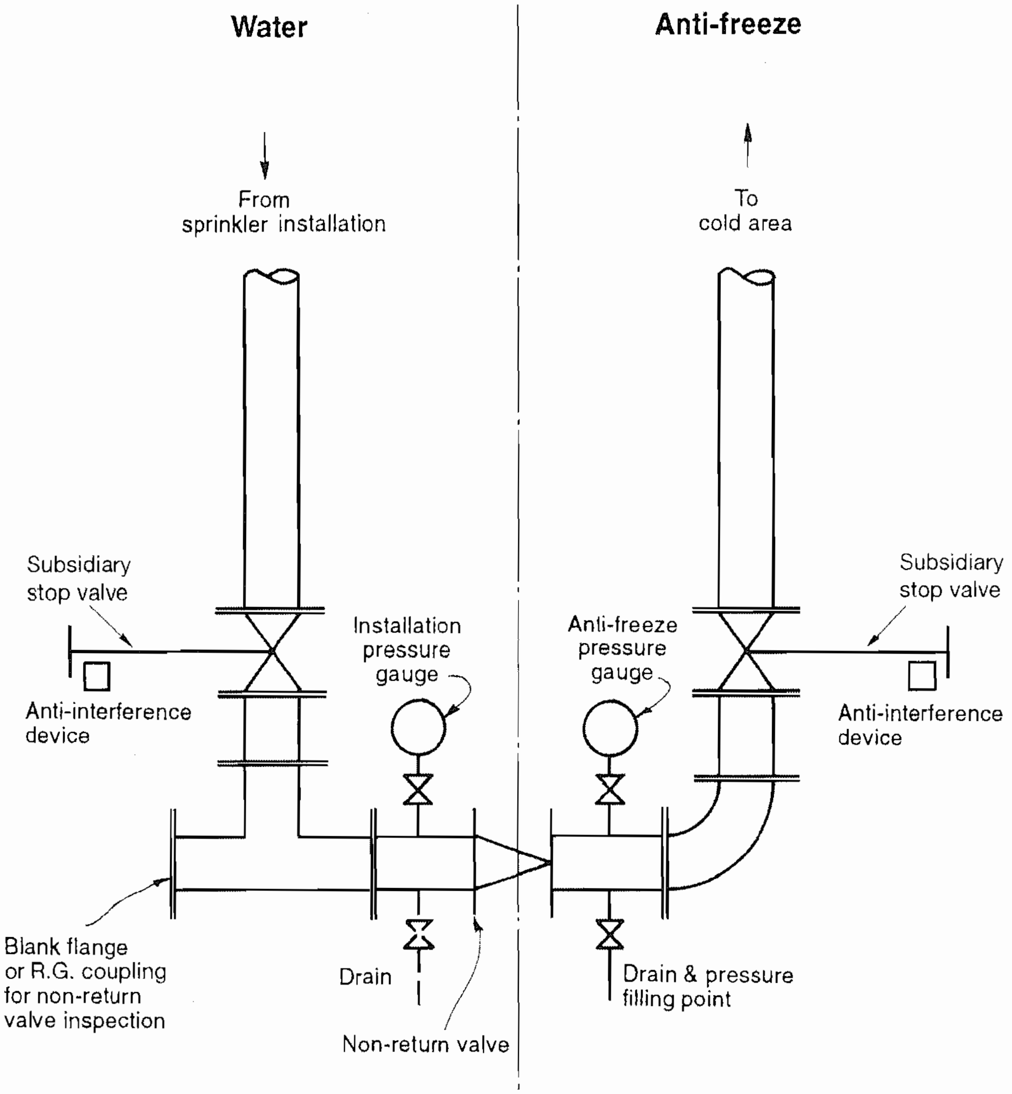
(1) Glycerine to be not less than 96.5 % purity.

(2) Previous editions of this Standard allowed the use of calcium chloride based antifreeze solutions. Installations installed to such superseded Standards shall be maintained with solution concentrations as specified by those Standards.

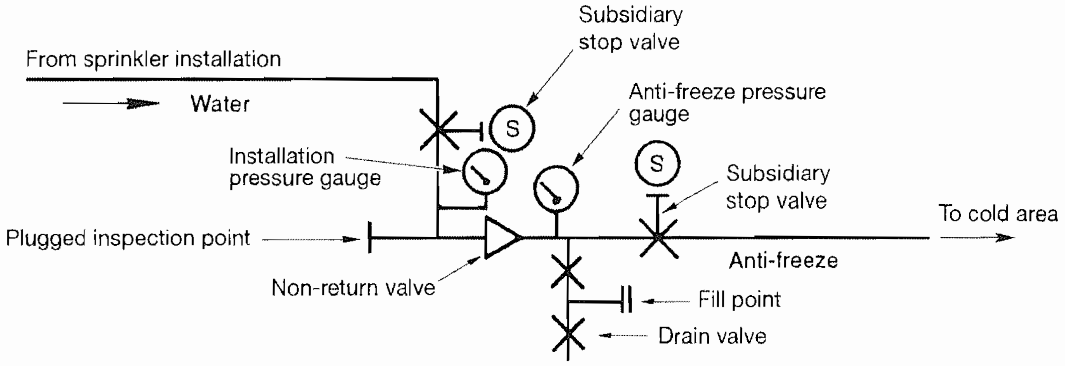
302.6.3

Antifreeze tail-ends shall be separated by a check valve with a pressure gauge and a subsidiary stop valve on either side of it. A device to permit draining, testing and repressurising of the antifreeze shall be provided on the downstream side of the check valve as shown in figure 3.1. This control equipment shall be in a readily accessible position outside the low temperature area. An indelible set of instructions for testing and refilling the tail-end shall be permanently affixed.

NOTE – The check valve required by this clause may be in the form of a listed backflow prevention device.



Typical arrangement 65 NB and larger



Typical arrangement up to 50 NB valves

NOTE – R.G. means roll groove.

Figure 3.1 – Typical tail-end antifreeze installation valves

302.6.4

Antifreeze systems shall be maintained at a pressure approximately 100 kPa above the installation water supply pressure, to ensure that dilution of the antifreeze solution does not allow ice plugs to form in the installation.

This requirement may be met by the installation of an automatically controlled jacking pump, drawing antifreeze solution from a reservoir. It is recommended that such an installation is carefully engineered, and includes precautions, such as a relief valve discharging into the reservoir, to ensure that the system is not over-pressurised due to thermal expansion.

302.6.5

Unless otherwise listed, sprinkler heads shall be installed in the upright position and pipework shall be arranged with adequate slope for drainage (see 403.11). An exception to this rule is allowed if listed dry pendent or dry sidewall pattern sprinklers are installed. A plugged drain valve at the lowest point of the installation and located within the low temperature area is acceptable with tail-end installations of no more than 20 heads.

302.6.6

The total number of sprinklers controlled by any section of any one tail-end set of valves shall not exceed approximately 100.

302.6.7

An expansion chamber shall be provided downstream of any check valve forming part of the antifreeze installation, to ensure that the installation, or part thereof, is not over-pressurised by the thermal expansion of the antifreeze solution.

A SSC may approve an alternative method of achieving this performance requirement, as part of an installation listing.

302.6.8

Full details of proposals for the installation of tail-end antifreeze installations shall be submitted to a SSC before any erection work is commenced.

302.6.9

The design of tail-end antifreeze installations in freezers or cold stores shall provide the ability to dismantle the system for removal of ice plugs, and to be able to inspect all main runs by provision of inspection tees or short easily removable sections of pipe. Extension of the main runs to outside the low temperature room, with straight line of sight, allows for usual inspection and lancing of ice plugs.

302.7 Antifreeze drops

Antifreeze drops shall not be used to provide freeze protection to sprinklers in small freezers or other small spaces.

NOTE – This does not imply that antifreeze drops installed prior to the publication of the 2003 edition of this Standard are to be replaced.

303 DELUGE INSTALLATIONS

303.1

Deluge installations are installations of open sprinklers controlled by a quick opening valve (deluge valve) which is operated by an approved installation of heat detectors, smoke detectors or sprinklers installed in the same areas as the open sprinklers.

303.2

These installations are designed primarily for extra high hazard process risks where intensive fires with a very fast rate of fire propagation are expected and it is desirable to apply water simultaneously over a complete zone in which a fire may originate by admitting water to open sprinklers or to medium or high velocity sprayers.

NOTE – ANSI/NFPA codes may provide design criteria for some risks normally protected by deluge systems.

303.3

Water spray installations use purpose designed open nozzles which may be controlled automatically or manually by quick opening valves. Water spray installations are designed for protection of special risks by extinguishment or by cooling to permit controlled burning or cooling to prevent heat damage.

303.4

The pipework for the open sprinklers or sprayers shall be fully hydraulically calculated to prove that the appropriate density of discharge will be available when all the sprinklers or sprayers in the installation are discharging.

303.5

If the deluge installation cannot operate without causing water damage, a supervised subsidiary stop valve shall be fitted immediately downstream of the deluge valve to assist in the maintenance and testing of the installation. A drain and test valve, fitted with a listed supervisory device, shall be located between the deluge valve and the downstream subsidiary stop valve to permit trip testing without flooding the installation. If a fire sprinkler inlet is attached to the installation it shall be connected to the installation upstream of the subsidiary stop valve to permit flow testing from the FSI. without flooding the installation. For tail-end deluge installations a supervised subsidiary stop valve shall also be provided immediately upstream of the deluge valve.

303.6

Full details of proposals for installation of deluge installations shall be approved before any erection work is commenced.

304 WATER MIST INSTALLATIONS

NOTE – Material regarding water mist installations is included in Appendix N of this Standard.

304.1

Water mist installations use specially designed nozzles to suppress, control, or extinguish a fire. The nozzles can be closed nozzles individually controlled via a fusible element (such as a standard sprinkler bulb), or can be open nozzles controlled by a deluge valve arrangement.

304.2

Water mist installations may only be used if listed by a SSC. The listing criteria may take precedence over other requirements of this Standard.

304.3

Water mist installations may be used as an equivalent to standard sprinkler installations, or to protect specialised risks, such as compartmentalised flammable liquid storage areas and machinery spaces, if they have been shown by full scale testing to be suitable for the application.

304.4

Water mist installations may take the form of wet pipe, dry pipe, pre-action or deluge installations. Water mist installations may be stand alone, or tail-end as an extension to a standard sprinkler installation.

305 METHODS TO DETERMINE WATER DELIVERY FOR GAS FILLED SPRINKLER INSTALLATIONS

305.1

Dry, tail-end dry and pre-action installations have prescriptive volume limitations, where it is not demonstrated that water can be delivered to the most remote sprinkler head within 60 seconds of head operation. This section provides two alternative methods to demonstrate that water can be delivered to the most remote sprinkler within the permitted 60 seconds.

305.2

It is permitted to exceed the volume restrictions provided in 302.2.3, 302.3.4 and 302.4.3 if it can be demonstrated via on-site testing that water can be delivered to an inspector's test connection, fitted to the remote part of the installation, and fitted with an orifice equivalent to the smallest sprinkler orifice in the installation, in not more than 60 seconds, starting at the normal installation standing air pressure.

305.3

An acceptable alternative approach to the physical test method allowed under this clause is to demonstrate that water will be available at the remote sprinkler heads within the time given in table 3.2 by calculation in accordance with the requirements specified in 305.4.

305.4

Calculations for water delivery time in gas filled sprinkler installations shall be based on the occupancy hazard shown in table 3.2.

Table 3.2 – Gas filled water delivery calculation design requirements

Occupancy hazard	Design number of remote sprinklers initially open	Maximum time of water delivery (seconds)
ELH (Residential Sprinklers)	1	15
ELH (Spray Sprinklers)	1	60
Ordinary Hazard	2	50
EHH (Process Risks)	4	45
EHH (High Piled Storage Risks)	4	40

The calculation program and calculation method shall be approved by a SSC.

Part 4
SYSTEM COMPONENTS

401 GENERAL

401.1 Acceptable equipment

Components that form part of a sprinkler system shall comply with the requirements of the Standard and must be listed where specified in this Standard. However, notwithstanding the specific requirements of this Standard, a Sprinkler System Certifier (SSC) may deem new technology to comply with the Standard. A SSC must be satisfied that the technology will detect and control fires with at least the same adequacy and reliability as existing technology permitted by the Standard.

401.2

No component of a sprinkler system shall be subjected, either during normal conditions or during operation, to pressures in excess of that for which the component is rated. Such rating may arise from the particular technical standard with which the component complies or as a condition of any listing of that component.

NOTE – This requirement will be particularly relevant in the case of high buildings or where there is a high standing pressure in the town's main. See also 407.2.1 and 211.4.

401.3

If the normal standing pressure exceeds 1,200 kPa, downstream of the alarm valve, a sign shall be installed in a normally visible place in the sprinkler control valve enclosure. The sign shall have 12 mm high lettering and read:

THE NORMAL STANDING PRESSURE OF THIS INSTALLATION EXCEEDS 1200 kPA. USE OF SYSTEM COMPONENTS WITH A WORKING PRESSURE OF (Installation Contractor to insert max. installation working pressure) kPa IS REQUIRED IF ANY ALTERATIONS ARE CARRIED OUT TO THIS SYSTEM.

402 SPRINKLERS

402.1 General

Sprinklers (including the make and type) shall be listed. They shall not be altered in any respect nor have any type of ornamentation or coatings applied after leaving the production factory except to provide corrosion resistance.

402.2 Types of sprinklers, sprayers and multiple controls

402.2.1

The following types of sprinklers are accepted for general use:

(a) *Conventional pattern.* These sprinklers are designed to produce a spherical type of discharge with a proportion of water being thrown upwards to the ceiling. They are usually designed with a universal type of deflector enabling the sprinkler to be erected in either the upright or pendent position. Some conventional pattern sprinklers are made in two types, one suitable for erection in the upright position and the other in the pendent position. The conventional pattern sprinkler is only suitable for installation on exposed pipes without the use of escutcheon plates;

NOTE – This edition of the Standard precludes the use of conventional sprinklers in extra light hazard and extra high hazard occupancies. This is a fundamental change from previous editions of the Standard, which mandated conventional sprinklers in such occupancies where the construction was of exposed structural steel. For existing extra high hazard systems, conventional sprinklers may be used in routine service activities.

(b) *Spray pattern.* These sprinklers are designed to produce a hemispherical discharge below the plane of the deflector with little or no water being discharged upwards to wet the ceiling. They are made in two types, one suitable for erection in the upright position and the other in the pendent position. They are available in various orifice sizes, with *K* factors ranging from 2.0 to 36. There are restrictions on orifice sizes in relation to design densities of discharge for spray sprinklers detailed in Part 9 of this Standard.

402.2.2

The following sprinklers are also accepted for general use subject to the qualifications mentioned:

Retracted deflector/Concealed sprinklers
Sprinklers of this type have spray pattern deflectors which remain concealed until the sprinkler operates. They shall not be used in atmospheres which are corrosive or have a high dust content, nor in any area where spray sprinklers are not permitted nor where the ceiling space above has a positive pressure.

402.2.3

The following special purpose sprinklers are accepted for use in the particular circumstances described:

(a) *Sidewall pattern.* These sprinklers are designed for installation along the walls of a room close to the ceiling. The design of the sprinkler is usually similar to the conventional pattern sprinkler except for a special deflector which causes most of the water to be discharged to one side in a pattern somewhat resembling one quarter of a sphere with a small proportion discharging on the wall behind the sprinkler. Sidewall sprinklers are available with standard and extended coverage patterns, and additionally, in residential models. They can be used with advantage in the case of drying tunnels and hoods over paper-making machines where condensate dripping from sprinklers and pipework at the ceiling might be troublesome. Also in certain other locations such as sale-shop windows and under platforms having low headroom, where standard sprinklers would be subject to damage, or under machinery where the use of other types of sprinklers is not practicable.

(b) *Dry pendent pattern.* These sprinklers are for use in portions of premises protected by a dry pipe system where it is not practical to install sprinklers in the upright position or on a wet pipe system where the sprinklers may be subject to freezing. They may also be used on pre-action and antifreeze systems where it is not practical to install sprinklers in an upright position. Apart from the valve arrangement, the sprinklers are of standard design having either conventional, pendent spray type or sidewall deflectors. They are manufactured integral with drop pipes of varying lengths, the valve being so placed that there is no pocket or depression within which water can be trapped.

(c) *Dry upright pattern.* These sprinklers are essentially the same as the dry pendent types except that if they are of the spray pattern an upright type deflector is incorporated. They are used for the protection of unheated concealed roof spaces in connection with installations on the wet pipe system.

(d) *Dry sidewall.* These sprinklers are essentially the same as dry pendent sprinklers but are fitted with sidewall pattern deflectors. They are used to protect areas which may be subject to freezing. They are available in both horizontal and vertical patterns and additionally, with extended coverage deflectors.

(e) *Control mode specific application (CMSA).* These are a closed head upright sprinkler, permitted for use in certain specified storage situations. Notably different rules concerning location, spacing and operating pressures apply. These sprinklers were known as Large Droplet sprinklers in previous editions of this Standard.

(f) *Residential.* These sprinklers are for use in those portions of premises that are classified as extra light hazard and as specified in Part 7 of this Standard. They feature a very low response time index, a higher than usual discharge trajectory and are available in pendent or sidewall configurations. Installation shall be in strict accordance with the listing concerning spacing, required pressure and distance below the ceiling.

A1 (g) *Suppression mode (SMS).* These are a special large orifice, closed head sprinkler incorporating a fast acting heat responsive element and are designed to deliver a water discharge intended to suppress fires. These sprinklers were known as Early Suppression Fast Response sprinklers in previous editions of this Standard.

(h) *Extended Coverage Ordinary Hazard (ECOH).* This is a spray pattern sprinkler designed to protect areas larger than 12 m^2/sprinkler within ordinary hazard occupancies. Installation shall be in strict accordance with the listing. Large scale fire tests have demonstrated that ECOH sprinklers installed in accordance with their listing provide equivalent fire control to standard sprinklers at 12 m^2 spacing. The use of ECOH sprinklers is limited to ordinary hazard occupancies other than:

  (i) Warehouses, stock rooms and other similar storage occupancies
  (ii) Spray application of flammable liquids
  (iii) Hydraulic equipment using flammable hydraulic fluids
  (iv) Vehicle assembly or repair areas where fuel is in fuel tanks
  (v) Any other occupancy involving flammable or combustible liquids.

NOTE – To achieve comparable detection, ECOH sprinklers are fitted with a more responsive heat activated element but are not necessarily listed as quick response sprinklers.

(i) *Extra Large Orifice (ELO).* These are a spray type sprinkler with a *K* factor greater than 11.5 which may be used in extra high hazard occupancies.

(j) *Extended Coverage Area Density (ECAD).* These are a spray sprinkler with an unusually large *K* factor used in extra high hazard occupancies. They may be used at normal spray sprinkler spacings, or at greater spacings in accordance with their listing criteria.

(k) *Extended Coverage Light Hazard (ECLH).* This is a spray pattern sprinkler designed to protect areas larger than 21 m^2/sprinkler within extra light hazard occupancies. Installation shall be in strict accordance with the listing. Their design criteria will reflect USA based light hazard design criteria, namely, a design density discharge of 4.1 mm/min, which may lead to a need to evaluate the cost benefits of a larger water supply, as against cost savings in greater coverage areas per sprinkler.

(l) *Specific application sprinklers.* These are special purpose sprinklers listed for the protection of special and unique hazards. Such sprinklers are to be used in accordance with their listing criteria.

NOTE – At the time of preparation of this Standard, specific application heads included, but were not limited to, window sprinklers, attic sprinklers, sealed mist sprinklers, water spray nozzles and combustible concealed space sprinklers.

402.2.4 *Medium velocity and high velocity sprayers*

These are special purpose sprayers for use in water spray systems (which may or may not form part of normal sprinkler systems) intended for the extinguishing or control of fires involving flammable liquids and for the cooling of storage tanks, process plant and exposed structural steelwork against

heat from an exposure to fire. These sprayers have directional discharge characteristics with cone angles ranging from 40° to 180° and with orifice sizes varying from 5 mm to 13 mm.
Features of the two types are as follows:

(a) Medium velocity sprayers are produced either as sealed sprayers with glass bulbs or soldered links and levers as for normal sprinklers or as open sprayers. They are designed essentially for cooling purposes when dealing with fires involving low flash point liquid hazards (below 66 °C) as for example, liquefied petroleum gases. In such risks, the aim is not for automatic extinguishing but to control the burning within safe limits until the source of gas supply has been shut off, thus avoiding the danger following a fire incident of these heavier-than-air gases continuing to escape and collecting in low lying areas producing an explosion hazard;

(b) High velocity sprayers are of the "open" type and are designed for the extinguishing of fires involving high flash point liquids (above 66 °C).

402.2.5 *Multiple jet controls (MJCs)*

These are heat-sensitive sealed valve controlled outlets, using either glass bulbs or soldered links and levers as the heat-sensitive device. They are for use in systems using sprinklers and medium velocity or high velocity sprayers of the "open" type in circumstances where it is required to operate small groups of sprayers simultaneously. The controls are made in various sizes relevant to the diameter of the valve and the number of sprayers that are to be fed from this valve. The sizes range from 20 mm to 80 mm.

402.3 Classification of sprinklers

402.3.1

Acceptable uses for each type of sprinkler head are indicated in table 4.1.

402.3.2

The *K* factors for each type of sprinkler shall be in accordance with those indicated in table 4.1 and 1005.5 unless noted otherwise in the listing.

K factor is the constant in the formula $Q = K\sqrt{P}$ where:
Q = Flow in L/min
P = Pressure in kPa.

402.3.3

Sprinkler head pipe thread form shall be compatible with the pipework connection.

402.3.4

Sprinkler head nominal orifice sizes shall be identifiable by one of the following means:

(a) Sprinkler heads shall be marked with a Sprinkler Identification Number (SIN Number) which will allow the sprinkler head characteristics to be identified from the manufacturer's published data; or

(b) 15 mm (K = 8.0) – unmarked. Where other orifices are used a pintle is fitted on the deflector;

   (i) The orifice size marked on the frame
   (ii) The *K* factor marked on the deflector
   (iii) 10 mm (K = 5.7) – The letters "ELH" marked on the frame
   (iv) 20 mm (K = 11.5) conventional or spray pattern – The letters "EHH" marked on the frame

(v) 15 mm Residential – “Residential” or “Res” marked on the deflector or heat collector, along with the *K* factor.

NOTE – All USA manufactured sprinklers have a unique Sprinkler Identification Number.

402.3.5

The types of sprinkler which are acceptable for each hazard class are set out in table 4.1.

Table 4.1 – Acceptable types of sprinklers

Hazard class	Type of sprinkler	Orifice (*K* factor)
Extra light	Spray (10 mm)*	5.7
	Spray (15 mm)	8.0
	Sidewall (10 mm)*	5.7
	Sidewall (15 mm)	8.0
	Sidewall (20 mm)	11.5
	Residential	(see listing)
	ECLH	(see listing)
Ordinary	Conventional	8.0
	Spray	8.0
	Sidewall	8.0
	Fast response	8.0
	ECOH	(see listing)
Extra high	Spray	8.0
	Spray	11.5
	ELO	16 or 24
	ECAD	36
	Suppression	20, 24, 32 or 36
	CMSA	16 or 24
	IRS	8.0 or 11.5
External	Spray, sidewall or listed drencher	8.0
*3/8 BSP is permitted only on existing systems when replacing 10 mm standard response sprinklers in sleeping areas.		

402.4 Temperature ratings

402.4.1

Sprinklers are available in nominal temperature ratings ranging from 57 °C to 260 °C.

402.4.2

The temperature rating chosen for ELH and OH shall be as close as possible to, but not less than 30 °C above the highest anticipated temperature conditions, unless otherwise specified in this Standard.

NOTE –

(1) For normal conditions, in temperate climates, ratings between 68 °C and 79 °C for commercial and industrial premises and between 57 °C and 68 °C for residential occupancies will be generally suitable.

(2) Under glazing and in unventilated roof spaces and in unventilated shop windows it may be necessary to install sprinklers with a temperature rating between 79 °C and 100 °C.

(3) See 302.4.2 for temperature ratings in pre-action systems.

(4) The following colour codes are used to distinguish sprinklers of different nominal temperature ratings, as noted below:

Fusible link sprinklers

Temperature rating (°C)	Colour of yoke arms
55/77	Natural (uncoloured)
80/107	White
121/141	Blue
163/191	Red
204/246	Green
260/302	Orange
320/343	Black

Glass bulb types

Temperature rating (°C)	Colour of bulbs
57	Orange
68	Red
79	Yellow
93	Green
141	Blue
182	Mauve
227/260	Black

NOTE – American manufactured fusible link sprinklers are not required to be colour coded from 1994 onward.

402.5 Sprinkler guards

402.5.1

In situations where sprinklers are liable to accidental or mechanical damage sprinklers can be protected by listed or approved guards.

402.6 Protective treatment of sprinklers

402.6.1

Sprinklers used where corrosive vapours are prevalent shall be protected against corrosion. This may be either by a listed corrosion resistant sprinkler suitable for the ambient temperature, or with a factory applied wax coating. Wax coatings shall be made good after installation.

402.6.2

Sprinkler heads located in areas of fouling may be protected from build up by the installation of a lightweight paper or plastic bag fitted over the sprinkler head.

402.6.3

Sprinkler heads used in areas subject to freezing shall be kept free from ice deposits. Ice on sprinkler heads shall not be removed by mechanical means.

NOTE – Ice formations on sprinkler heads can prevent early fire detection and may interfere with the discharge spray pattern. Mechanical removal of ice formations is likely to result in damage to the sprinkler head.

402.7 Replacement sprinklers

402.7.1

Unless otherwise allowed by 402.7.5 the contractor shall provide at the control valves, or at the fire pump enclosure, a cabinet or bracket to contain spare sprinklers. Such sprinklers shall be kept in a place where the ambient temperature does not exceed 38 °C.

402.7.2

The contractor shall provide six spare sprinklers of the type and temperature ratings used widely in the installation.

402.7.3

Where small quantities of sprinkler heads are used in the installation, at least one spare sprinkler shall be provided.

NOTE – This clause is to ensure that a sprinkler system can be readily recommissioned following sprinkler activation. Examples of spares that are required to be provided for compliance under this clause would include a spare dry barrel sprinkler of each length, deflector type and temperature rating used in the installation, and a spare high temperature head of each temperature rating used to protect a kitchen hood. If large quantities of these specialised heads are used in an installation, the number of spare sprinklers maintained on the site should be increased accordingly.

402.7.4

The contractor shall also provide a spanner suitable for each type of sprinkler installed.

402.7.5

Where the installation is within 100 km of the service provider, the requirement to provide standard spare sprinklers as defined in the table below is waived, on the undertaking that the service provider will undertake to carry standard spares in their after hours call-out vehicle.

Standard sprinklers are defined below:

Sprinkler orifice size	**Type of sprinkler**	**Temperature rating**
10 mm	SSP or SSU	68 °C or 93 °C
15 mm	SSP, SSU or C/UP	68 °C or 93 °C
20 mm	SSP, SSU or C/UP	68 °C or 141 °C

402.7.6

Sprinklers requiring replacement shall be replaced by a sprinkler of equivalent type or, in the case of residential sprinklers, of the same design criteria.

402.8

Escutcheon plates, including decoration, shall be of metal or thermosetting plastic and designed and fixed not to adversely affect the water distribution or detection functions of the sprinkler. They shall not be used to support ceiling or other structures. One piece escutcheon plates meeting these criteria do not require listing.

Two piece or recessed escutcheon plates shall be listed, either as individual units, or in conjunction with the listing of sprinklers. Two piece escutcheon plates shall only be listed for use in accordance with the relevant sprinkler data sheet specifications.

Two piece escutcheon plates shall not be used with conventional (C/UP) sprinklers, unless included in the specific sprinkler listing.

403 PIPEWORK

403.1 Compliance with Standards

403.1.1

Pipes upstream of alarm valves shall comply with the Standards and jointing methods in table 4.2. All steel pipes shall be galvanised or concrete lined internally, and where installed underground provided with an exterior protective coating, to satisfy any TA requirements.

NOTE – It is the intention of this clause that steel pipework upstream of any backflow prevention device and the alarm valve be protected from internal corrosion.

Table 4.2 – Pipes to be used upstream of control valves

Pipe	Jointing options
PVC-U to AS/NZS 1477 PVC-M to AS/NZS 4765 PVC-O to AS 4441 (Int)	Solvent cement or elastomeric seal jointing in accordance with AS/NZS 2032
Mild steel to AS 1074 Heavy and medium weight BS 1387 Heavy and medium weight ASTM Schedule 20, 200 mm dia. and above Schedules 30 & 40, 150 mm dia. and below	Flanged, screwed, or mechanical coupling (medium weight – roll grooved only)
NZS 4442	Slip on mechanical coupling, or flanged. (Roll groove type couplings precluded.)
Polyethylene pipes – to AS/NZS 4130 (buried pipe only)	Butt fusion, flange joints, electrofusion couplings or mechanical couplings
Copper to NZS 3501	Brazed or flanged joint, or mechanical coupling
Any other pipe investigated for suitability in automatic sprinkler systems, and listed as such by a SSC.	In accordance with listing
NOTE – (1) Asbestos cement pipes with proprietary joints installed below ground prior to 1991 are also permitted. (2) Attention is drawn to the need to consider dissimilar metal corrosion such as may occur between copper and galvanised steel pipework.	

403.1.2

Pipes downstream of the alarm valves shall comply with the Standards and jointing methods in table 4.3.

Table 4.3 – Pipes to be used downstream of alarm valves

Pipe	Jointing options
Mild steel to AS 1074 Lightweight ASTM Schedule 10, 150 mm dia. and below BS 1387 Lightweight AS 4041 Lightweight	Flanged, mechanical coupling (roll grooved only)
AS 1074 Medium weight BS 1387 Medium weight AS 4041 Medium weight	Screwed, flanged, mechanical coupling (roll grooved only)
API 5L Grade B, ASTM A53 or ASTM A135 Schedules 30 & 40, all sizes Schedule 20, or 4.8 mm wall thickness, 200 mm dia. and above AS 1074 Heavyweight BS 1387 Heavyweight	Screwed, flanged, mechanical coupling
API 5L Grade B, ASTM A53 or ASTM A135 Schedule 5, 20 mm to 50 mm dia.	Proprietary systems as listed by FM or UL
Copper to: NZS 3501	Brazed joint or capillary soldered fitting
Chlorinated PVC to: ASTM F442 with SDR of 13.5 Subject to the limitation of 403.1.3	Solvent cement with CPVC fittings to: ASTM F439
Stainless steel to: ASTM A312 Schedules 10, 40 and 80; all sizes	Welded joints or fittings to ASTM A403, mechanical coupling (roll grooved or cut grooved, subject to wall thickness) Subject to limitations of 403.1.4
Polyethylene pipes – to AS/NZS 4130 (buried pipe only)	Butt fusion, or electrofusion couplings
A1 Any other pipe, investigated for suitability in automatic sprinkler systems, and listed as such by a SSC	In accordance with listing
NOTE – Attention is drawn to the need to consider dissimilar metal corrosion such as may occur between copper and galvanised steel pipework.	

403.1.3

Chlorinated PVC is permitted only:

(a) When the pipe, fittings and solvent cement are of manufacture listed by FM or UL and for which the manufacturers' recommended cure times prior to pressurisation of the system do not exceed 6 hours at 15.5 °C;

(b) When installed and supported in accordance with the associated instructions and any limitations of the manufacturer:

  (i) In extra light hazard and ordinary hazard group 1 occupancies

  (ii) Any pipe supplying room sprinklers shall have quick response sprinklers or be protected behind a continuous barrier of not less than 1.6 kg/m^2 density

  (iii) Pipe may only be used in ceiling spaces which are free from combustibles or are sprinkler protected using quick response sprinklers.

Sprinkler heads shall not be fitted to CPVC pipework before the jointing cement has cured so as to avoid rundown of cement into the sprinkler.

403.1.4

Stainless steel pipe is permitted provided that:

(a) Pipe and fittings are of grades 304, 304L, 312, 312L, 316 and 316L only;

(b) Threaded joints are used only for schedule 40 and 80 pipes of up to 50 mm diameter;

(c) Welded joints and joints made with welded fittings are post heat treated as required by ASTM A312 for the grade of steel concerned.

403.2 Underground pipework

403.2.1

Underground pipes shall be protected against corrosion where necessary. Where pipes are carried under vehicle traffic areas, the pipe covering shall be such as to maintain the load on the pipe within safe tolerances. PVC pipe shall be installed in accordance with the requirements of AS/NZS 2032. Polyethylene pipes shall be installed in accordance with AS/NZS 2566 and NZS/AS 2033.

Where petrolatum tape systems are used the complete system shall be used. Petrolatum cloth tape is only part of the system.

403.2.2 *Testing of underground fire mains and pump start lines*

The installing contractor shall be responsible for performing all required acceptance tests, and completing and signing the contractor's material and test certificate.

All underground pipework is to be flushed at a velocity of not less than 3 m/s until the discharge remains clear prior to connection to the automatic sprinkler installation.

NOTE – A water supply producing velocities of 3 m/s may not be available under all circumstances. If such a velocity is not available, then the system's maximum anticipated demand should be simulated to clear any foreign matter that may obstruct the pipework.

All piping and fittings subjected to system working pressure shall be hydrostatically tested at 1400 kPa, or 350 kPa in excess of the system working pressure, whichever is greater, and shall maintain that pressure without loss for 2 hours.

Prior to carrying out the hydrostatic testing the pipe shall be flushed of debris and purged of any trapped air to ensure that an accurate test is achieved.

A test certificate suitable for recording results of testing is provided in Appendix M.

403.3 Hot work jointing

403.3.1

Any pipe joints may be joined using hot work subject to the following restrictions:

(a) All welding of steel pipes shall be carried out to the requirements specified in 108;

(b) Except in exceptional circumstances, in the case of sprinklers being installed during the construction of the protected building only pipes of 50 mm NB or greater may be joined by hot work *in situ*, hot work in smaller pipes shall be fabricated in the contractor's workshop;

(c) Where sprinklers are being installed in an existing building, *in situ* hot work shall not be permitted except in exceptional circumstances and then only in accordance with 1104;

(d) For service or alteration work on existing sprinkler systems 'cut-in' hot work operations are only permitted to the extent specified in 1104.

403.4 Concealment of pipework

403.4.1

Sprinkler pipework should not be embedded in concrete except where short sections are required to negotiate structural members and sleeving is not practical. Bends are preferred to joints in this section but otherwise the pipe shall be welded, pressure tested, and wrapped before immersion in concrete. The wrapping shall extend beyond the edge of the concrete.

NOTE – Embedding of pipework is restricted to avoid problems of corrosion and difficulties in making subsequent alterations to the system.

403.5 Feed pipes in high temperature areas

403.5.1

Sprinklers in ambient temperatures above 100 °C shall be on a dry pipe installation or the feed pipes thereto shall rise up to the sprinklers (or group of sprinklers) so as to restrict the thermal circulation of the heated water in the pipes.

403.6 Restriction regarding pipework in unsprinklered firecells

403.6.1

Sprinkler pipework shall not pass through, or be supported on an unsprinklered firecell unless there is no practical alternative, in which case 403.6.2 shall apply.

403.6.2

The sprinkler pipework shall be accessible for inspection and contained within a protected shaft or surrounded with fire resistant materials and be supported by elements having a FRR no less than the *S* value derived from the t_e in table 5.1 of Compliance Document C/AS1 Part 5 of the New Zealand Building Code Fire Safety Clauses for fire hazard categories 1, 2 and 3, subject to a maximum of 120/120/120. Protection in fire hazard category 4 situations shall be to a specific fire engineered design or a FRR of (180)/180/180.

NOTE –

(1) The above conditions are intended to prevent damage or collapse of the pipework in the event of a major fire in the unprotected building.

(2) For pipework, valves and fittings in buildings or sections of premises in which particularly hazardous processes are carried on, or an explosion hazard exists, special precautions apply (see 404.11).

403.7 Protection of pipework against corrosion

403.7.1

Unpainted or otherwise unprotected mild steel pipe is permitted for interior use if there are no corrosive environmental conditions present and the pipe has not been subjected to corrosive conditions prior to installation.

NOTE – Attention is drawn to differences in corrosive conditions that can occur in particular areas of a building (e.g. toilets) or in different areas of a city (e.g. areas close to the sea), or in different parts of New Zealand (e.g. Rotorua) and to the requirements of some owners (e.g. hospitals and industrial plants) to colour code various piping systems.

403.7.2

Where corrosive conditions exist, pipework should be thoroughly cleaned and protected by suitable means, for example by a corrosion-resistant protective system.

NOTE –

(1) In some corrosive environments galvanising may be adequate provided that the threaded ends of the pipes are adequately sealed with a suitable protective coating; and/or

(2) The pipes may be wrapped in a suitable protective tape system in accordance with the manufacturer's instructions.

403.7.3 *Earthing*

The use of any sprinkler installation pipe as an earthing continuity conductor is prohibited. A thimble stud shall be welded upstream of any device or fitting connected to each metal underground water supply pipe to permit earth bonding.

NOTE –

(1) Attention is drawn to the necessity to comply with the requirements of the Electricity Act and Regulations.

(2) If an electrical hazard is suspected then an earth strap should be fitted across any installed pipes before they are cut.

403.8 Protection of system against mechanical damage

403.8.1

Sprinkler pipework should not be erected in locations where it is prone to damage by forklift trucks and other mobile equipment. In particular, it should not cross gangways where such equipment is used unless the headroom is in excess of the height of the equipment concerned. Where it is impracticable to avoid areas subject to such traffic, the pipework should be protected by adequate guards. Where installation valves or risers are situated in such areas, in addition to guard rails, safety guide lines should be marked out.

403.9 Pipe supports

403.9.1

Fixings shall be heat and corrosion resistant in the location chosen and installed so that they are designed to support five times the weight of the water-filled pipe plus 100 kg. Additionally hangers shall not yield when loaded to five times the weight of water-filled pipe plus 100 kg. Supports shall allow for thermal movement.

403.9.2

Electrical wiring or other services, fittings or fixtures shall not be attached to, or supported by, sprinkler pipework.

Sprinkler pipework should not be supported from other services unless the supports have been engineered to the requirements of AS/NZS 1170 series.

403.9.3

Pipes shall be supported at such intervals that the bending stresses will not exceed 50 % of the yield figure when the pipes are full of water. The *l/r* value should not exceed 300, where *l/r* is the ratio of the length between supports and the radius of gyration of the pipe section.

Support systems outside the scope of the table below shall be by specific design.

Suitable supports for horizontal simply supported steel pipes are noted in table 4.4.

Table 4.4 – Suitable supports

Pipe size (mm)	**Max. spacing** (m)	**Min. hanger rod diameter** (mm)
20	2.4	10
25	3.3	10
32	4.25	10
40	4.8	10
50	6.0	10
65	6.5	10
80	6.5	10
100	6.5	10
150	6.5	12
200	6.5	16
Over 200	6.5	24

The unsupported length between the end sprinkler and the last hanger on a range of two sprinklers or more shall not be more than 900 mm for 25 mm pipe and 1200 mm for 32 mm pipe and larger.

Hangers are not required on range pipes not exceeding 600 mm fed directly from distribution pipes with rigid connectors. Where the distance between supports for distribution pipes exceeds the maximum permissible span, the intermediate distribution pipe hanger may be omitted provided the range pipes are supported from each purlin adjacent to the distribution pipe.

CPVC pipes shall be supported according to the listing instructions of the manufacturer (see 403.1.3(b)).

403.9.4 *Special provision for factory formed insulated panels*

Special precautions are required for fixing to factory formed insulated panels. The design for fixings shall be approved by a SSC and may require certification by a Chartered Professional Engineer. Alternatively, the design for fixings shall include the following:

(a) When attaching sprinkler range pipework to the underside of factory formed insulated panels the fixings shall penetrate both skins of the panel. Suitable load spreading plates shall be provided with the fixings on both side of the panel.

(b) Where factory formed insulation panels are designed for a temperature controlled atmosphere or for weather protection any fixings penetrating the panels shall be thermally insulated to reduce heat transfer and all external fixings shall be sealed against the ingress of water.

(c) Fixing range supports to one side of the panel using pop rivets, or self-tapping screws is not permitted.

(d) Distribution pipework shall not be affixed to factory formed insulated panels unless a specific engineered solution has been provided by a Chartered Engineer and approved by a SSC.

(e) The use of plastic fasteners, such as nylon through bolts is not permitted.

NOTE –

(1) The requirement to preclude plastic fasteners is based on a review of a number of failures, where the fasteners have catastrophically failed, with the system falling from the building ceilings. A review of literature has indicated that nylon will embrittle when in contact with moisture, zinc and the chemicals used to provide fire retarding to expanded polystyrene. These materials are usually all present with sprinkler system supports.

(2) The requirement which precludes pop rivets and the like is based on a review of range pipe support failures following two significant fires in 2005.

403.10 Pipe size

403.10.1 *System pipework*

For all new sprinkler systems the sizing of the system pipework shall be by full hydraulic calculation in accordance with Part 10 of this Standard.

In the case of extensions to existing systems installed to superseded editions of this Standard, the tabular method of pipe sizing may be used as permitted by Part 7 for extra light hazard, or Part 8 for ordinary hazard classifications. Detailed requirements for extra light and ordinary hazard classifications are set out under their respective sections.

Existing sprinkler systems of extra high hazard classification, installed to superseded editions of this Standard may be extended to a maximum of 18 sprinkler heads, based upon the superseded edition of this Standard to which the existing system was installed.

403.10.2 *Water supply pipework*

Pipe sizes for pump suctions from tanks are specified in 606.3.8. Other pipework is sized by the designer by hydraulic calculation according to the nature and parameters of the supply.

403.10.3 *Reduction in sizes*

Except for fully hydraulically calculated systems, pipes may diminish in diameter only in the direction of flow of water to any sprinkler.

403.10.4 *Orifice plates*

Where it is considered necessary to fit orifice plates in order to assist in balancing a system hydraulically or to meet pump characteristic curves, the diameter of the orifice shall not be less than 50 % of the diameter of the pipe into which the plate is to be fitted. Such orifice plates are allowed only in pipes of 50 mm diameter or larger. They shall be of brass or stainless steel with plain central holes without burrs and not less than the following thickness:

Pipe size (NB) (mm)	50	65	80	100	150	200
Min. plate thickness (mm)	3	3	3	6	6	9

They shall be situated not less than five pipe diameters upstream and downstream from any elbow or bend measured in the direction of flow. Orifice plates shall have a projecting identification tag which is readily visible on which is stamped the nominal pipe diameter and the K factor for the orifice. The relationship between the size of the orifice, the flow and the pressure loss may be calculated on the basis of the information given in Appendix E.

403.11 Slope of pipes and provision for drainage

403.11.1

The distribution and range pipes of all gas filled systems shall be sloped to suitably placed installation drain points. The slope on pipes of 50 mm and over shall be at least 1 in 500 and on smaller pipes at least 1 in 250.

403.11.2

The drain point shall be fitted with a normally closed and plugged or locked drain valve at least one third the diameter of the supply pipe to the part of the installation being drained. Where practicable these drain valves should be positioned to discharge into a disposal sump or drain so as not to cause flooding within the building.

403.11.3

For wet pipe systems normally closed and plugged or locked drain valves shall be provided to allow all distribution pipes to be substantially (although not necessarily completely) drained.

403.12 Seismic resistance of pipework – Design

403.12.1

The sprinkler system pipework shall be supported to resist seismic loads by either:

(a) A complete piping support system based on a dynamic seismic analysis such that the pipework system performance shall be at least equal to that of the building structure under the earthquake loadings of NZS 1170.5; or

(b) A piping support system which shall comply with the requirements of 403.12.1 to 403.13.4 inclusive.

NOTE – The design of the support system to resist seismic loads on pipework is based on the following principles:

(1) Lateral supports are of sufficient stiffness to force piping to move with the immediate support structure;

(2) Lateral supports are spaced to limit pipe deflections under resonating dynamic load such that pipe joints and intermediate vertical supports are not over-stressed;

(3) Lateral supports are ductile and fixings are designed over-strength;

(4) Stresses due to differential movements of building structures are minimised through the use of piping flexibility or clearances.

403.12.2

All pipework shall be designed to resist repeated forces due to seismic acceleration of 1.0 g acting on the mass of the pipework in any direction in addition to the gravity force.

NOTE – This load may be greater than the requirements of NZS 1170.5, and may increase the support size but it eliminates the need for a more detailed study.

403.12.3

All fixings in materials which fail in a brittle manner, such as concrete or timber, shall have a safety factor of not less than two.

NOTE – The pipework lateral supports are detailed for limited ductility and over-strength is required in fixings to prevent brittle failure at loadings greater than the design earthquake.

403.13 Seismic resistance of pipework – Installation

All sprinkler pipework shall be suitably designed and installed to support and resist seismic loads. A piping support system shall be designed to comply with AS/NZS 1170: Part 0 and NZS 1170: Part 5.

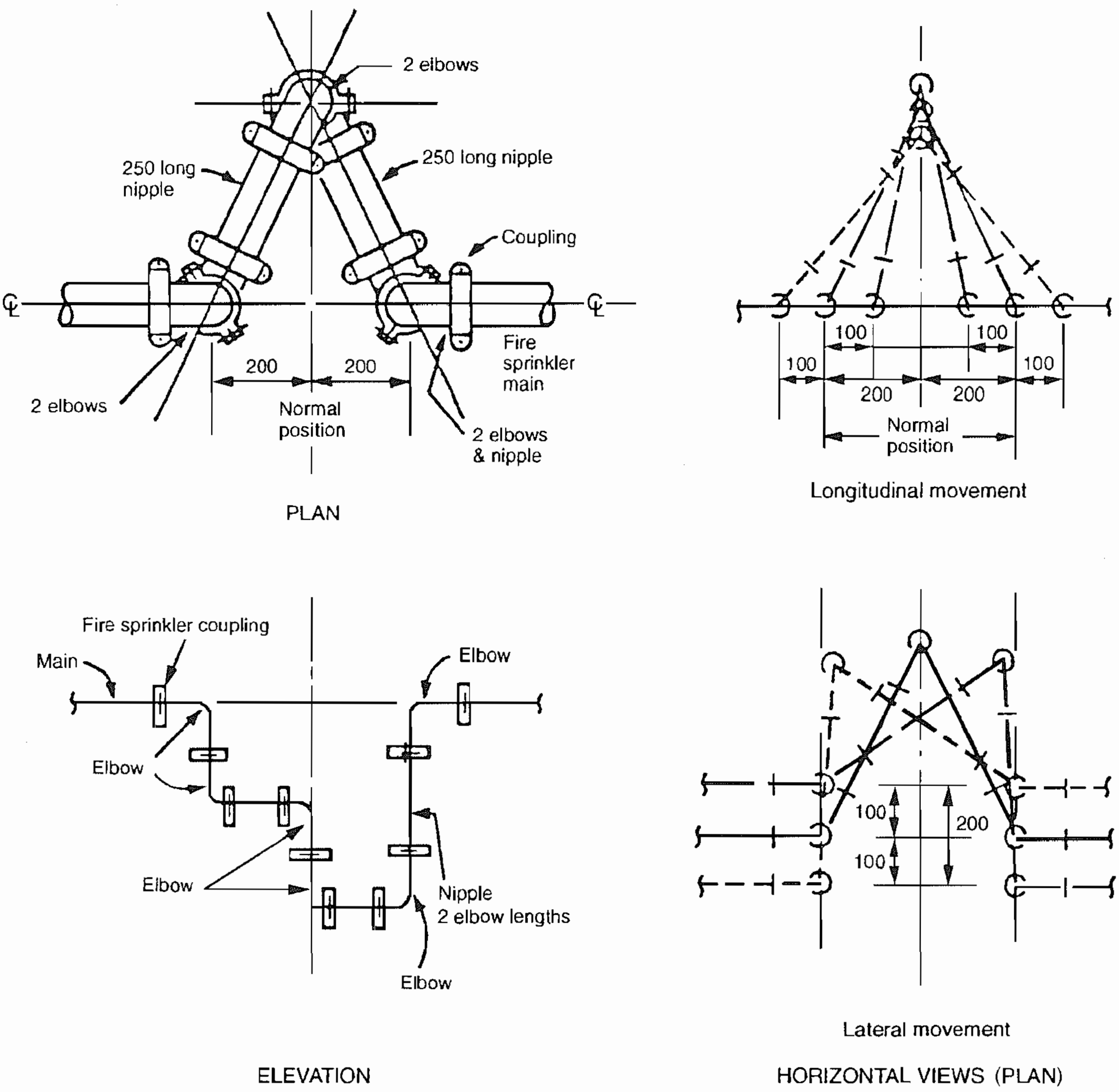
All parts of structures, including permanent, non-structural components and their connections, and permanent services and equipment supported by structures shall be designed for the earthquake actions specified in NZS 1170: Part 5 section 8.

403.13.1 *Flexibility*

403.13.1.1

Pipework shall have sufficient flexibility to prevent over-stressing of pipes, hangers and braces in an earthquake. Flexibility shall be provided in the X, Y and Z axes at structural separations.

NOTE – A swing joint able to take movements of ±100 mm is shown in figure 4.1.



All dimensions are in mm.

Figure 4.1 – Seismic flexible joint

403.13.1.2

Sufficient flexibility shall be provided in risers and distribution pipes to allow for ±80 mm horizontal movement per 4 m of height of the building. Where piping crosses structural separations, an allowance for relative horizontal movement is required of either ±160 mm per 4 m of height of the structural separation or the building design movement where known. Where risers pass through more than one floor and are more than 1 m from a column or structural shear wall, either the form of the fixing or the pipework flexibility shall allow for differential movement between floors.

403.13.1.3

Range pipes shall not pass through structural separations.

403.13.1.4

Flexibility shall be achieved through piping flexibility or by the use of flexible couplings of the mechanically housed type providing axial and lateral pipe connection which is equivalent to the pipe strength.

403.13.1.5

Thin-walled metal expansion bellows type couplings may only be used where:

(a) The ends of the piping being connected are fixed to the structure; and

(b) The rating of the bellows allows for 150 % of the anticipated differential movement in all directions.

Rubber type couplings are not acceptable.

NOTE – A single length of braided hose will not provide three planes of movement.

403.13.1.6

Flexible couplings shall be provided within 600 mm to 900 mm of non-structural concrete or masonry walls to which pipework is rigidly fixed, or to alternatively ensure adequate piping flexibility. This shall also apply to sections of pipework attached to different parts of the building, including racking systems, that may respond differently in an earthquake, e.g. between a wall and a roof or between basement walls and the ground, or between a rack and a wall.

403.13.2 *Bracing*

403.13.2.1

The requirements of this section are applicable to steel pipework only.

403.13.2.2

Bracing shall be provided to restrain pipework under seismic load. Hangers not longer than 150 mm measured from the top of the pipe to the point of hanger support can be used for lateral bracing and, if clamped tightly to the pipe, for longitudinal bracing also, provided that in both cases the hanger will not break or detach under the seismic load.

NOTE – Piping hangers that do not provide lateral restraint are not braces.

403.13.2.3

Bracing shall be positioned and aligned in conjunction with flexible couplings such that no bracing is subject to seismic load from pipework outside its immediate vicinity. Typical locations of pipework bracing within a building are shown in figure 4.2. Tributary lengths of pipe for various bracing locations are shown in figure 4.3. These can be used with the data in table 4.5 to calculate the weight of pipework to be restrained.

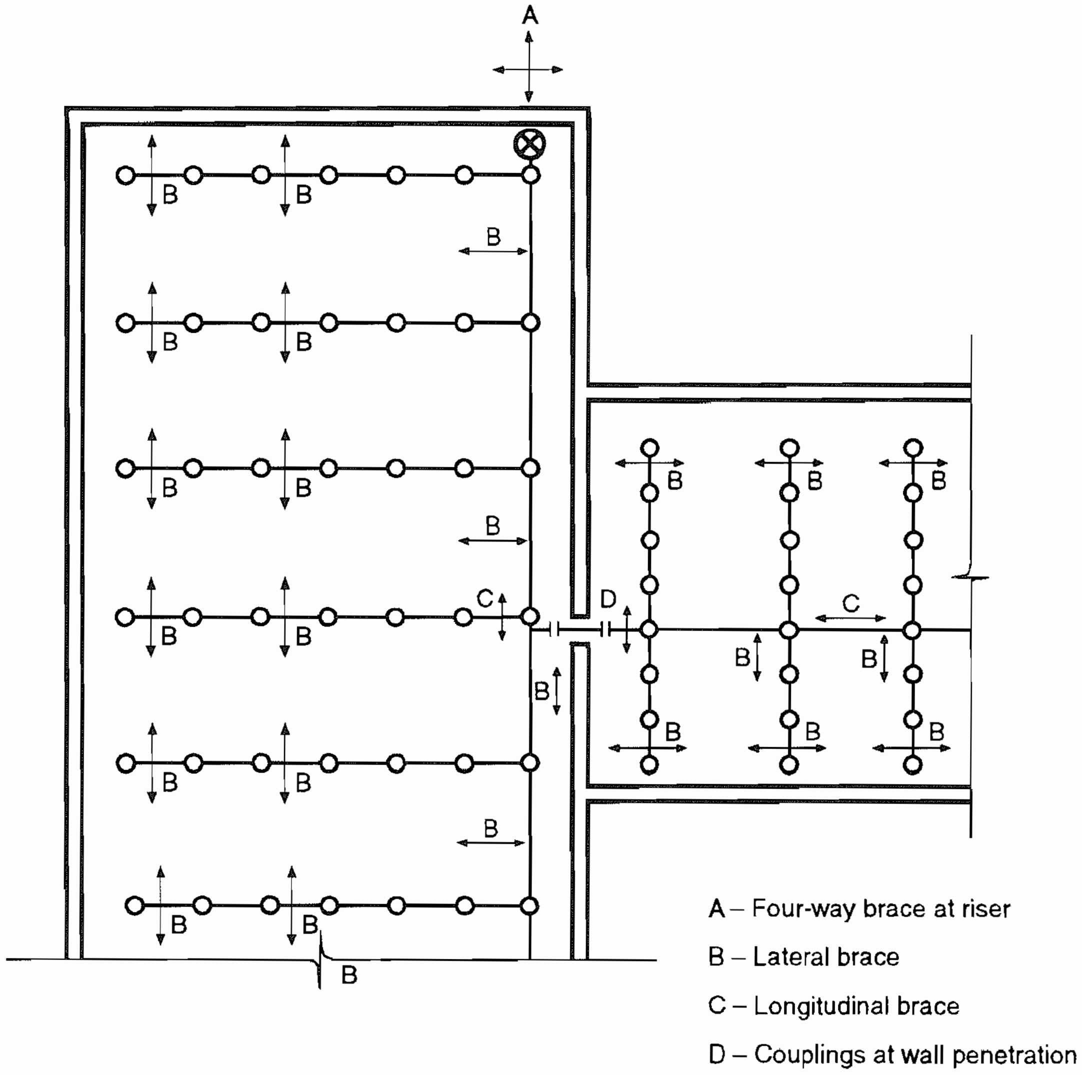
Table 4.5 – Weight calculations

Pipe size (nominal diameter) (mm)	**Weight including water (W_p)** (kg/m)	**Material**
25	3.05	BS 1387 medium screwed and socketted tube
32	4.19	
40	5.03	
50	7.37	
65	10.3	
80	13.7	
100	21.1	
150	38.8	
200	62.6	BS 3600 tube

NOTE – For a seismic acceleration of 1.0 g the required restraining force F_p is given by:

(1) $F_P = W_P \times 0.00981 \times L_P$ (kN)

(2) where L_P = length of pipe under restraint.



A – Four-way brace at riser

B – Lateral brace

C – Longitudinal brace

D – Couplings at wall penetration

Figure 4.2 – Location of pipework bracing

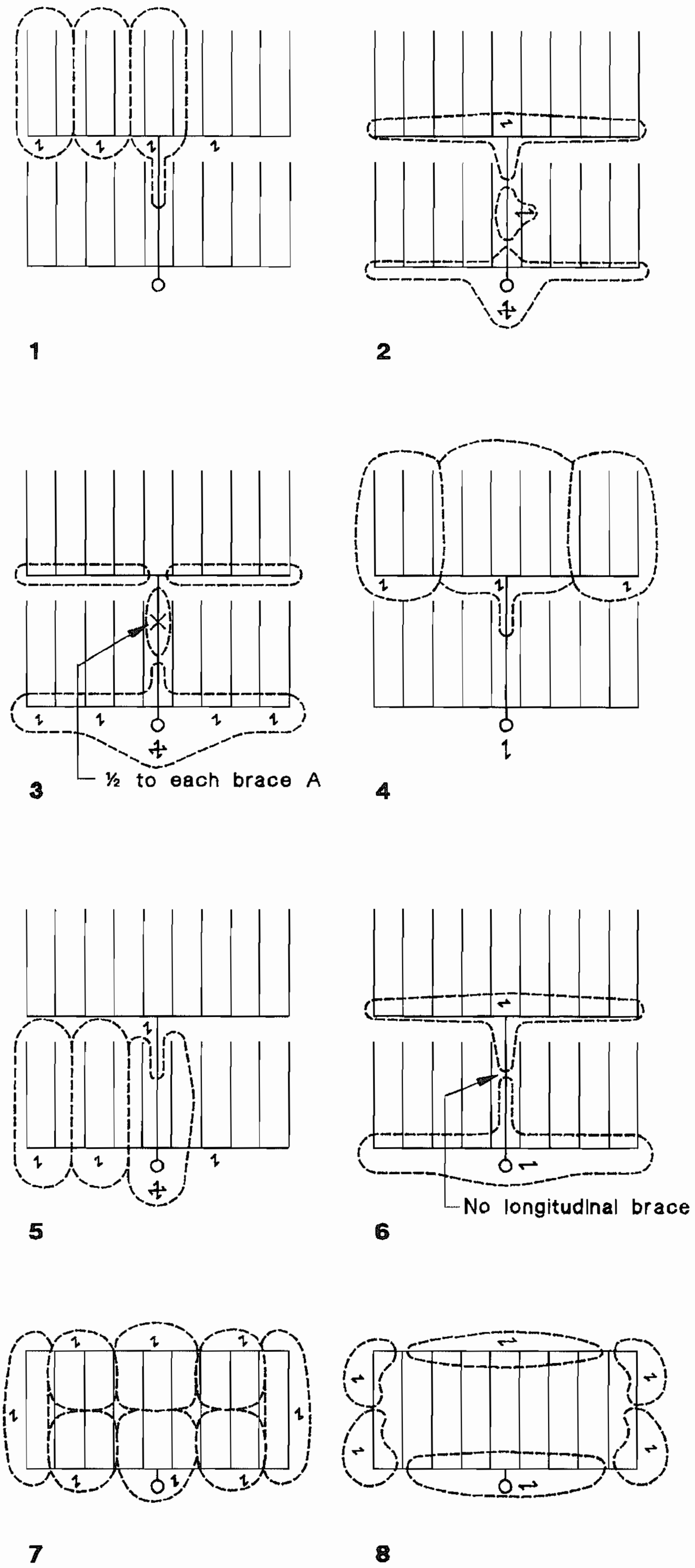


Figure 4.3 – Examples of load distribution to pipework bracing

403.13.2.4
Distribution piping shall be provided with bracing:

(a) Laterally at less than 1.2 m from unrestrained ends;

(b) Laterally at main building structural elements, with a maximum spacing of 12 m;

(c) Laterally within 600 mm of a flexible coupling (on at least one side);

(d) Laterally within 600 mm of both sides of a swing joint crossing a structural separation;

(e) Which includes at least one longitudinal brace.

A right angle change in direction of a pipe, or second pipe teed off it, can provide the required longitudinal restraint of the pipe provided the branch pipe is of equal or larger size and is laterally restrained within 600 mm of the connection.

403.13.2.5
Risers shall be provided with bracing to resist movement in both lateral directions:

(a) At less than 1.2 m from unrestrained ends;

(b) At a maximum spacing of 6 m.

403.13.2.6
Range pipes shall be provided with bracing:

(a) Laterally on the last hanger;

(b) Laterally at a maximum spacing of 12 m.

NOTE – The restraint at the end of the range pipe is intended to prevent the pipe from whipping and possibly detaching from the end hanger.

403.13.2.7
Tension/compression braces shall be at an angle to the vertical of not less than 30°. Acceptable types of bracing are shown in figure 4.4.

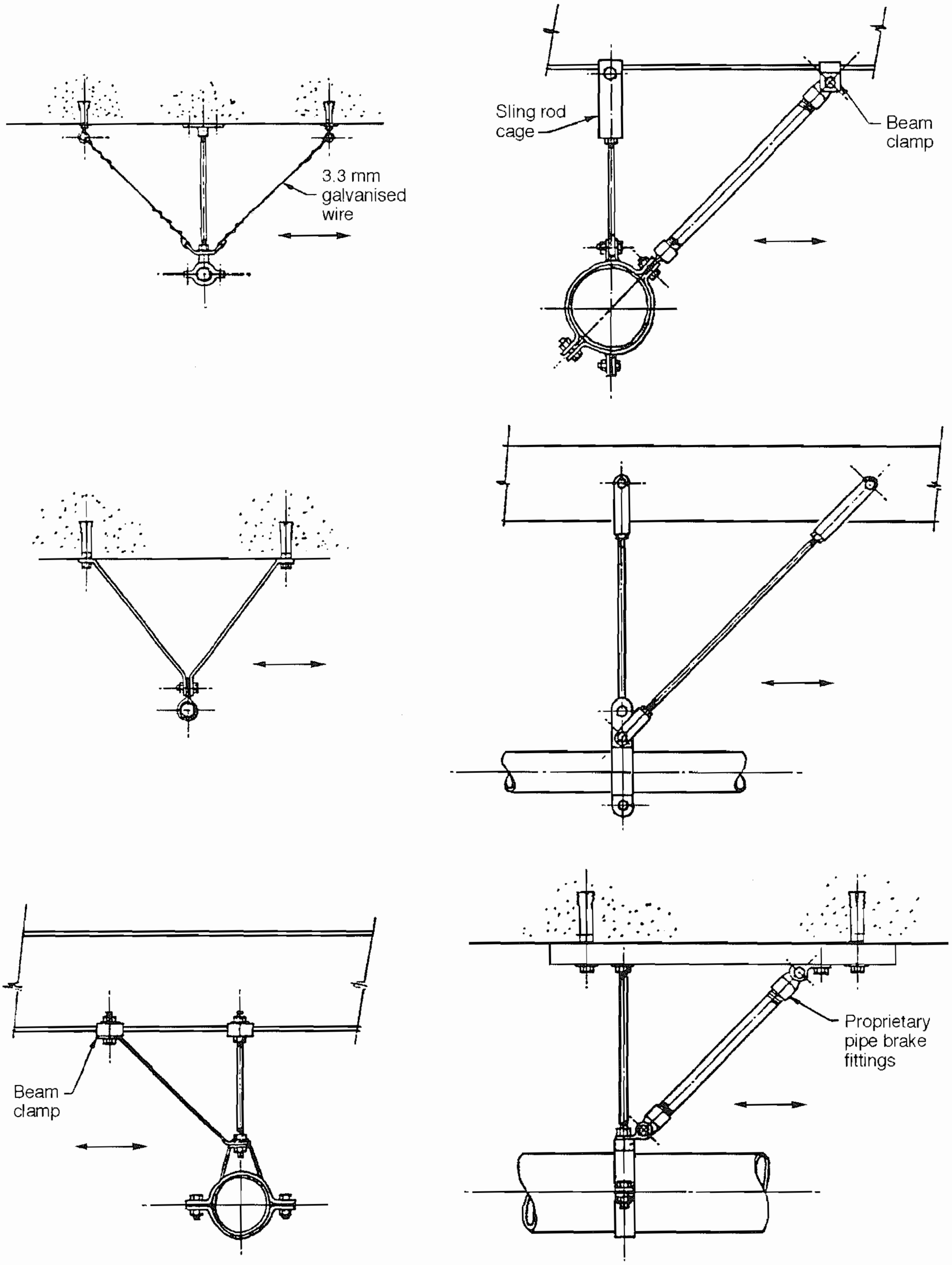


Figure 4.4 – Pipework bracing details

403.13.2.8

The slenderness ratio *l*/*r* of compression braces shall not exceed 200, where:

l = length of brace
r = radius of gyration of brace.

The maximum horizontal loads that can be resisted by compression braces at various brace angles are shown in table 4.6.

Table 4.6 – Allowable horizontal loads of typical pipework braces

Shape and size	Allowable horizontal support load				
	Brace length for *l*/*r* = 200	30° angle from vertical	45° angle from vertical	60° angle from vertical	Horizontal
(mm)	(m)	(kN)	(kN)	(kN)	(kN)
Galvanised steel wire					
3.2 dia.	(tension only)	0.23	0.33	0.40	0.45
Mild steel rod					
10 dia.	0.50	1.0	1.4	1.7	1.9
12 dia.	0.60	1.4	2.0	2.4	2.8
16 dia.	0.80	2.5	3.5	4.3	5.0
20 dia.	1.00	3.9	5.5	6.8	7.8
BS 1387 medium tube					
20 NB	1.7	2.5	3.5	4.3	5.0
25 NB	2.2	3.9	5.5	6.8	7.8
32 NB	2.8	5.0	7.1	8.7	10.1
40 NB	3.2	5.7	8.1	9.9	11.5
50 NB	4.0	8.1	11.5	14.0	16.2
65 NB	5.1	10.4	14.7	18.1	20.8
Mild steel flat					
40 x 6	0.35	3.0	4.2	5.2	6.0
50 x 8	0.46	5.0	7.0	8.6	10.0
50 x 10	0.58	6.2	8.8	10.8	12.5
Mild steel angle					
25 x 25 x 3	0.96	1.7	2.5	3.0	3.5
30 x 30 x 5	1.1	3.4	4.9	6.0	6.9
40 x 40 x 5	1.5	4.7	6.7	8.2	9.4
50 x 50 x 5	1.9	6.0	8.4	10.3	12.0
60 x 60 x 6	2.3	8.6	12.2	14.9	17.2
80 x 80 x 6	3.1	11.6	16.5	20.2	23.3

403.13.2.9

Bracing shall be tight and concentric. All parts and fittings of a brace should be in a straight line to avoid eccentric loading on fittings and fastenings.

403.13.2.10

The connection of a brace to piping shall be snug and tight. The connection to the piping shall be able to transfer load from the pipe to the brace and remain tight under vibration.

403.13.2.11

Lateral bracing shall be perpendicular to the piping.

403.13.2.12
Bracing for range pipes may be provided by wrap around U hooks with the legs bent out at least 10° from the vertical.

403.13.2.13
Bracing fixings to the piping and to the immediate support structure shall be designed to resist the earthquake loading specified in 403.12. The horizontal loads that can be resisted by typical fixings for various bracing configurations for horizontal piping are shown in table 4.7 subject to the following provisions:

(a) Masonry anchors shall be installed to the manufacturer's specifications;

(b) Bolts to steel members shall comply with the requirements (e.g. edge distances) of NZS 3404;

(c) Bolted and screwed connections to timber shall comply with the requirements of NZS 3603.

403.13.2.14
Bracing for piping of diameter 80 mm or larger shall not be restrained by timber members which are less than 100 mm in the direction(s) of the plane(s) of bending. The distance of the point of fastening from any edge of the timber shall be not less than 30 mm or 4 fastener diameters whichever is the greater.

403.13.2.15
Braces shall not be welded to cold rolled sections 3 mm or less in thickness.

403.13.2.16
Explosive driven fasteners shall only be used if listed.

403.13.2.17
Expansion fasteners in concrete which are secured by driving the fastener against a wedge at the bottom of the hole shall not be used.

NOTE – This type of expansion fastener has performed poorly in earthquakes.

403.13.2.18
The building element to which the brace is fixed shall be capable of withstanding the force which the brace imposes on it.

403.13.3 *Clearance*

403.13.3.1
Clearance, as specified in 403.13.3.2, shall be provided around all piping extending through non-structural walls, floors, platforms and foundations as follows.

403.13.3.2
Minimum clearance on all sides from the building elements shall not be less than:

Piping up to 40 mm nominal diameter.....................25 mm
All other pipes ....50 mm

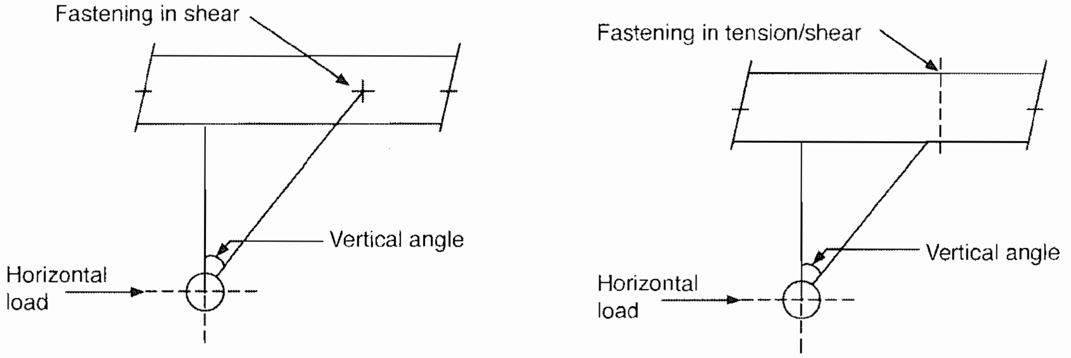
The gap may be sealed provided that a flexible or frangible material is used.

403.13.3.3

No clearance is required for piping passing through partitions or walls of frangible materials (such as gypsum board) unless the wall is required to have a fire resistance rating.

Table 4.7 – Horizontal load capacity of typical connections

Fastening type	Horizontal load capacity					
	Vertical angle 30°		Vertical angle 45°		Vertical angle 60°	
	Type A (kN)	Type B (kN)	Type A (kN)	Type B (kN)	Type A (kN)	Type B (kN)
Masonry anchors						
M6	1.7	1.3	2.4	2.0	2.9	2.6
M8	3.0	2.0	4.2	2.9	5.2	3.8
M10	4.4	2.9	6.2	4.3	7.6	5.5
M12	6.8	4.3	9.5	6.3	11.7	8.7
M16	12.0	5.7	17.0	8.7	20.9	12.3
Bolts to steel						
M6	1.7	1.9	2.4	2.6	2.9	3.0
M8	3.0	3.5	4.2	4.6	5.2	5.4
M10	4.7	5.5	6.7	7.3	8.1	8.5
M12	6.8	7.9	9.5	10.5	11.7	12.3
M16	12.0	14.4	17.0	19.1	20.9	22.0
Bolts to BP 450 purlins						
M6	1.7	–	2.4	–	2.9	–
M8	2.9	–	4.1	–	5.0	–
M10	3.6	–	5.1	–	6.2	–
M12	4.3	–	6.1	–	7.4	–
M16	5.7	–	8.1	–	9.9	–
Bolts to timber						
M12	2.1	–	3.3	–	4.4	–
M16	2.9	–	4.8	–	7.1	–
M20	3.7	–	6.4	–	10.0	–
Coach screws to timber						
M8	–	0.75	–	0.95	–	1.1
M10	–	1.3	–	1.8	–	2.2
M12	–	1.8	–	2.6	–	3.4
M16	–	3.0	–	4.2	–	5.6
M20	–	4.3	–	6.2	–	8.4



Type A **Type B**

NOTE –

(1) Bolted shear (type A) connections to timber assume a nominal timber thickness of 50 mm.

(2) Tension/shear (type B) connections to timber assume coach screws penetrate timber 10 times the shank diameter and have a minimum thread length 6 times the shank diameter.

(3) The loads for timber connections are for dry timber. For green timber reduce the loads by 30 %.

403.13.3.4

No clearance is required if the piping is attached rigidly to the wall and there is adequate piping flexibility on both sides of the wall to prevent damage from movement of the pipework under seismic loads.

403.13.3.5

In walls required to be fire rated the gap shall be filled with a flexible material which will preserve the fire rating of the wall.

403.13.4 *Hangers*

403.13.4.1

Hangers shall be connected to the piping and to the immediate support structure by fixings that cannot detach in an earthquake.

404 VALVES

404.1 Installation control valves

404.1.1 *General*

Each installation shall be provided with a set of installation control valves comprising:

(a) A main stop valve;

(b) An alarm valve (wet pipe, dry pipe, composite or a deluge valve);

(c) A water motor alarm and gong;

(d) A drain valve.

Figures 4.6, 4.7 and 4.8 show typical layouts including ancillary equipment.

404.1.2 *Enclosure*

The sprinkler installation control valves shall be protected and secured in a substantial sprinkler protected enclosure, exclusive to the sprinkler installation. This enclosure shall be of sufficient size to allow adequate access to all parts of the sprinkler control valves and associated equipment, together with due provision for artificial lighting, adequate ventilation and heating (the latter as necessary). It shall also permit servicing and testing in a weather protected environment.

NOTE –

(1) Where there is no danger of freezing a robust, locked, wire-mesh enclosure within a protected building will comply with this requirement.

(2) The need to comply with the Electricity Regulations should be noted.

(3) AS/NZS 3000 *Electrical installations* (known as the Australian/New Zealand *Wiring rules*) is a suggested means of compliance. As sprinkler control valve enclosures can be wet areas on occasions, the provisions of 2.9.2.5 (Restricted locations of switchboards) and 6.7 (Locations where general hosing down operations are carried out) should be considered. The use of Residual Current Devices (RCD) is also recommended for the protection of socket outlets (refer to 2.6).

404.1.3 *Location*

Control valves need to be designed, arranged and provided in locations that allow for the carrying out of all the required testing, inspection and maintenance. In this regard adequate drainage is required for the flow of water for testing and inspection of water supplies.

NOTE – The New Zealand Fire Service is preparing "A guide to Fire Service operations in buildings" which will provide a recommended specification for locks used in sprinkler systems.

404.2 Stop valves

404.2.1 *General*

All stop valves shall be suitable in all respects for the proposed application. Valves which exceed 50 mm diameter and are subject to a pressure exceeding 100 kPa shall be so constructed that the operating mechanism has a mechanical efficiency of less than 50 %.

Stop valves that are below ground (or floor level), are only accessible via toby boxes and are key operated shall be used only on the water supply. Such valves shall close in the anti-clockwise direction.

All other valves shall have a handwheel or a lever permanently affixed and handwheel operated valves shall close in the clockwise direction. Handwheel and lever operated valves shall have a permanently fixed indicator to show if the valve is open or closed and shall be clearly marked to show the direction of closing or opening.

404.2.2 *Main stop valves*

These shall comply with the following:

(a) Each installation shall be provided with a main stop valve, which when closed will shut off all supply of water to the installation. All water supplies shall be connected before passing through the main stop valve;

(b) Main stop valves shall be fitted with a supervisory device, and secured open by a padlocked chain or a padlocked strap;

(c) The location of the main stop valve shall be identified by a location plate fixed on the outside of an external wall and if necessary a further plate on any opaque door within the building which has to be opened in order to gain access to the main stop valve. Such plates shall bear the following words in raised letters or other approved type of letters:

SPRINKLER
STOP VALVE
INSIDE

The words "SPRINKLER STOP VALVE" should be in letters of at least 35 mm and the word "INSIDE" of at least 25 mm in height. It is recommended that the words be painted white on a black background.

404.2.3 *Stop valves controlling water supplies*

Except as noted in 404.2.1, all stop valves controlling water supplies shall be secured open by a padlocked chain or a padlocked strap. In the case of elevated private reservoirs and gravity tanks the stop valve shall be fixed immediately adjacent to the reservoir or tank outlet and shall be upstream of any flexible couplings. All water supply stop valves within the pumproom shall be fitted with a listed supervisory device.

404.2.4 *Subsidiary stop valves*

Stop valves subsidiary to the main stop valve shall be fitted with a listed supervisory device. They shall be located in a prominent position, clearly labelled, and accessible from floor level or by a permanent access ladder/platform provided for New Zealand Fire Service and service personnel.

NOTE – In high rise buildings, the floor isolation valves should be normally located within a common stairwell likely to be used by New Zealand Fire Service personnel to access the fire floors.

Stop valves subsidiary to the main stop valve are permitted only under the following circumstances and subject to the following conditions:

(a) To isolate individual floors in multi-storeyed buildings as per 211;

(b) To isolate individual buildings or tenancies in malls when fed from a single installation;

(c) To isolate buildings or sections of premises, as per 404.11, where either hazardous processes are carried out or conditions exist which are liable to result in an explosion;

(d) To facilitate maintenance and testing of:

  (i) Dry pipe installations (see 302.2)
  (ii) Tail-end dry pipe installations (see 302.3)
  (iii) Pre-action installations (see 302.4)
  (iv) Antifreeze installations (see 302.5)
  (v) Tail-end antifreeze installations (see 302.6)
  (vi) Deluge installations (see 303)
  (vii) Backflow prevention units (see 404.3.4);

(e) With specific approval, when frequent shut down of a section of a sprinkler installation is required to gain access to equipment or to clean sprinklers;

(f) To isolate a section of in-rack sprinklers (see 904.2.8);

(g) Where subsidiary stop valves are installed to allow sectional isolation of sprinkler installations, as outlined in (a), (b), (c) (e) and (f) above, then the following conditions apply:

  (i) It is not permissible to have looped connections which require more than one valve to be operated to sectionally isolate part of the installation; AND
  (ii) Multiple subsidiary stop valves shall not be installed in series.

404.2.5 *Valves with supervisory devices*

Supervisory devices shall be listed. They may be listed as part of a valve assembly or as an individual unit. For normally open or normally closed valves the supervisory device shall detect and activate when the spindle of the valve is rotated any more than two revolutions from the normal position, or, for quarter turn valves, the valve opening changes by more than 15° from the normal position.

The signalling function shall be either line powered by the fire brigade alarm transmission system, or alternatively, powered by a power supply complying with 407.2.5.

Activation of the supervisory device, due to either valve closure or interference with the device, shall cause transmission of a FIRE signal by the fire brigade alarm within 60 s. The signalling path and any supplementary source shall be supervised in such a way that open circuit or loss of power will also cause transmission of a FIRE signal.

Isolation devices on the alarm signalling function (to permit authorised valve closure of a subsidiary stop valve) shall be located in the fire brigade alarm unit and be appropriately labelled. Activation of the isolation device shall cause the fire brigade alarm to signal DEFECT.

Valves other than those required to be supervised by this Standard may be fitted with supervisory devices if required. An example being pump suction isolation valves. In such cases, operation of the supervisory device shall not preclude the ability of the fire brigade alarm to transmit a FIRE signal.

404.2.6

Taps, hose reels or other attachments for drawing water from an installation other than those specified in this Standard are strictly forbidden.

404.3 Protection of potable water supplies

404.3.1

Backflow prevention shall be installed to protect public and on-site potable water supplies. In-ground hydrants that are part of the building shall be backflow protected. The method of protection shall be as required by Compliance Documents of the New Zealand Building Code Clause G12.

NOTE –

(1) Backflow protection for the building is required in accordance with Approved Document for the New Zealand Building Code Clause G12.

(2) 'Buildings' are as defined in section 3 of the Building Act.

404.3.2

Devices to provide backflow prevention installed in the supply to a sprinkler system shall be listed and any strainers fitted shall be listed and comply with 404.10.

404.3.3

Backflow prevention devices shall be readily accessible for testing and maintenance. Backflow prevention devices located upstream of installation valve sets shall be located in a secure area. This secure area shall be either within the sprinkler valve house or sprinkler pump room, or where a TA requires a backflow prevention unit to be installed at the property boundary its location and security shall be subject to SSC approval. In the latter case the contractor shall provide a SSC with copies of documentation from the TA specifying their required location.

Backflow prevention devices require valves upstream and downstream for testing and maintenance purposes. If fit for purpose, the street valve and main stop valve may meet this need. Alternatively, additional stop valves with listed supervisory devices shall be installed.

Reduced pressure zone devices shall always be located above ground, and unless specifically recommended by the manufacturer, be located horizontally with the relief valve facing vertically downward and not less than 300 mm above the surrounding surface.

Double check valve assemblies may, if absolutely necessary, be installed below ground with specific approval of the TA and provided that:

(a) The double check valve assembly is located in a permanent (concrete) pit that is a suitable size to allow for inspection, testing, maintenance and replacement;

(b) The pit is suitably drained and covered to prevent water pooling or silting; and

(c) The location is clearly indicated on the block plan.

Backflow prevention devices located outside the sprinkler valve or pumproom shall be protected from freezing.

404.3.4

A drip tight valve and pipework are required to be installed downstream of any backflow prevention device to allow it to be tested. The main sprinkler stop valve, or valves, may provide this function. Valves are required upstream of backflow prevention devices for maintenance purposes. The main town's main isolation valve may provide this function.

NOTE – In some cases, the main sprinkler stop valve will not be sufficient to allow the backflow prevention device to be tested. One possible scenario would be if the device is installed upstream of a fire pump with a packed gland. In normal circumstances, it would be expected that any backflow prevention device be installed downstream of a pump, to avoid hydraulic disturbances, which would impact on pump performance. Specific approval is required for such installations, which would detail the requirements for security and monitoring of any valving installed on the supply to the sprinkler system.

404.4 Alarm valves

404.4.1 *Alarm (wet pipe) valves*

Alarm (wet pipe) valves (often referred to as "ordinary" alarm valves) shall be of a listed type.

404.4.2 *Alarm (dry pipe) valves*

Alarm (dry pipe) valves (often referred to as "air valves" or "dry pipe valves") shall be of a listed type and shall comply with the following:

(a) They shall be fixed on the main supply pipe immediately above the main stop valve (and the alarm (wet pipe) valve in the case of installations not employing a composite alarm valve) and before any connection is taken off to supply any part of the installation;

(b) In the case of installations maintained permanently under gas pressure, the water motor alarm shall be connected to the atmospheric chamber or the alarm motor auxiliary valve of the alarm (dry pipe) valve;

(c) In order to facilitate the carrying out of flow tests when the installation is under gas pressure, an additional 40 mm drain valve in the case of extra light hazard installations or a 50 mm drain valve in the case of ordinary and extra high hazard installations may be fitted below the alarm (dry pipe) valve. Alternatively, a subsidiary stop valve of a listed type may be installed immediately above the alarm (dry pipe) valve.

404.4.3 *Composite alarm valves*

These valves which shall be of a listed type, are dual purpose valves suitable for either wet or dry installations. The conditions in 302.1, 302.2 and 404.4.2 as appropriate are equally applicable for this type of alarm valve.

404.4.4 *Identification of alarm valves*

NOTE – In buildings containing more than one installation each alarm valve shall have a number indicated thereon in bold figures.

404.5 Dry pipe and preaction installations in freezers

Factory Mutual Global's Data Sheet 8-29 provides useful background information on the design of dry pipe installations for refrigerated storage applications.

404.5.1 *Accelerators or exhausters for alarm (dry pipe) valves*

When fitted, these devices which shall be of a listed type are designed to accelerate the operation of an alarm (dry pipe) valve. They shall be located as close as possible to the alarm (dry pipe) valve. Care shall be taken to ensure that the connection to the device from the system is so located that the restriction orifice and other operating parts are not likely to become flooded with priming water or back drainage under normal conditions (see also 302.2).

It is permissible to further enhance the speed of operation of a dry pipe installation to trip an accelerator or exhauster by means of a signal from a thermal or smoke detector system (see 302.2.3) which covers the area protected by the dry pipe system. Details of such arrangements shall be submitted for prior approval.

404.5.2 *Air supply*

Dry pipe installations shall be fitted with an air supply capable of restoring normal air pressure in 30 minutes.

Air pressure in the installation shall not exceed that recommended by the dry pipe valve manufacturer. A listed air pressure maintenance device shall control air pressure.

In cold storage applications, air shall be supplied through an adequately sized twin tower desiccant type regenerative air dryer, so its pressure dew point is 10 °C below the nominal freezer temperature. The air dryer shall be installed upstream of the air pressure maintenance device. The air supply shall be connected to pipework inside the freezer, to ensure that the air is fully chilled and has deposited its frost before it enters the sprinkler water line.

NOTE –

(1) Air intake for compressed air should be taken from the freezer operating at the coldest temperature.

(2) Consideration should be given to redundancy in air supplies. It is recommended that twin air supply lines are used as shown in FM Data Sheet 8-29.

(3) Attention is drawn to the critical nature of this plant. If the power supply fails, the dry pipe installation is at risk of tripping, with consequential freezing. It is recommended that the compressor be supplied from any site emergency power supply if available.

404.5.3 *Pipework*

In addition to the provisions for drainage in 403.11, pipework shall be fabricated to allow easy inspection of pipework and to facilitate disassembly to remove ice plugs.

Rigid grooved couplings shall be used in freezer applications, except where flexible grooved couplings are required for seismic flexibility requirements. Gaskets used in freezer applications shall be recommended for such service by the coupling manufacturer.

NOTE – Gaskets used in freezers will have a special seal to close off the gap between the pipes, to minimise the possibility of moisture freezing inside the gasket surface, and disrupting the seal. Care should be taken in the selection of gasket lubricants, as standard lubricants may freeze. Suitable gasket lubricants can include petroleum-free silicon based lubricants.

404.6 Automatic pressure and flow regulating valves

404.6.1 *General*

Automatic pressure/flow regulating valves shall be of a type listed for the task involved.

The trim on pilot operated valves shall be approved and be connected to the water supply to be controlled, through a suitable strainer, and piped in hard copper, steel or stainless steel tubing. The pilot valve strainer shall be in the automatic pressure or flow regulating valve's main water path, and be designed to be self-cleaning. Use of Y pattern strainers in the pilot operated valve trim tubing is not acceptable.

There shall be permanent facilities associated with all automatic pressure/flow regulating valves to enable the correct functioning of the valve to be verified on site.

When under test the delivery from the valve shall stabilise within 20 seconds of any change in the input without the output at anytime rising more than 100 kPa above the required controlled pressure.

404.6.2 *Pressure reducing valves on water supplies*

Listed pressure reducing valves controlling sprinkler water supplies shall be equipped with a listed pressure relief valve set to relieve to waste any downstream pressure that rises above the intended controlled pressure. The relief valve shall be sized to vent not more than 5 % of the design flow to waste.

404.6.3 *Pressure sustaining valves*

Where listed pressure sustaining valves are used to control domestic or industrial draw-off from the sprinkler system water supply:

(a) The pressure sustaining valve shall be of a type, and installed in such a way, that failure of the valve operating device shall cause the valve to close;

(b) The pressure sustaining valve shall be configured to preserve the water supply pressure available to the sprinkler system by either:

   (i) Causing the pressure-sustaining valve to close on a drop in the installation pressure to the FIRE signal activation pressure, or

   (ii) Causing the pressure-sustaining valve to close on a drop in supply pressure to below 80 % of the normal static supply pressure. This pressure setting is to be reviewed and agreed with a SSC;

(c) A clearly labelled device, interlocked with the fire brigade alarm, may be provided within a fire brigade alarm unit to permit the pilot operated devices on the pressure sustaining valve to be bypassed when the installation pressure has been lowered for servicing purposes. A notice in the fire brigade alarm signalling unit shall clearly alert the need to restore the bypass device.

A valved bypass up to 40 mm, around the pressure sustaining valve is permitted, and shall be provided if hose reels are supplied by the domestic or industrial supply.

404.6.4 *Pressure relief valves*

Listed pressure relief valves may be used to automatically relieve pressure surges, in pump cooling lines, or to bypass excess pressure. On pump relief lines a strapped (not locked), normally open, gear operated stop valve shall be provided upstream. The stop valve shall be labelled "PUMP RELIEF LINE VALVE" in letters of at least 12 mm and there shall be an associated sign with 25 mm lettering prominently displaying "TO INCREASE PUMP SUPPLY PRESSURE IN EMERGENCY, SHUT THE PUMP RELIEF LINE VALVE".

Where a pump draws water from a tank, it is preferred to return the pressure relief line to the tank with the outlet below the minimum water level and away from the vortex plate to avoid air entrainment. When this is not practicable then the pressure relief line shall enter the pump suction pipe at an angle of 90° at least 10 pipe diameters upstream of the pump suction flange. There shall be an approved visual indicator of water flow in the pump relief line, or a valve position indicator on the pressure relief valve.

404.6.5 *Other automatic control valves*

Listed automatic flow control valves shall be used for tasks on sprinkler systems where remote or automatic control of water is required. These tasks include the control of infill into supplementary tanks, quick discharge of installation pressure for remote hydraulic anti-interference devices etc.

404.7 Deluge and pre-action valves

404.7.1

Deluge valves which shall be of a listed type are employed to control the water supply to an array of open sprinklers or sprayers which are required to discharge simultaneously. The valve is normally held closed and is released automatically either by a loss of pressure from independent pipework carrying sprinkler heat detectors or initiated by the operation of an approved heat or smoke detection system. Alarm equipment is normally connected to the outlet pipework from the valve so that an alarm is given when water flows into the distribution pipework. See also 303.

404.7.2

Pre-action valves, which shall be of a listed type, are similar in use to a deluge valve except that the sprinkler pipework will be charged with gas under pressure and fitted with closed sprinklers. The normally closed valve is opened by the operation of a separate installation of detection sprinklers on small diameter, gas-filled pipework. See also 302.4.

404.8 Drain valves

404.8.1

A drain valve shall be fitted at the installation control valves to provide the functions of drainage, pressure switch testing where appropriate and water supply checking.

404.8.2

For installations up from extra light hazard to and including ordinary hazard group 3, the drain valve and attached pipework shall be sized to allow the discharge of the highest design flow at the related design pressure. For ordinary hazard 3 special and extra high hazard installations, the drain valve and attached pipework shall be 50 mm in diameter.

404.8.3

The valve shall be clearly labelled and shall be locked or strapped shut.

404.8.4

The discharge pipe shall not have a diameter smaller than that of the drain valve.

404.8.5

The discharge pipe shall terminate in a sump or drain capable of disposing of the full open discharge of the drain valve without causing flooding in the building. Discharge of the drain test directly onto a sealed surface, such as a carpark, is permitted where the discharge will not cause damage or undue risk to the public.

404.9 Water meters

Water meters shall be listed. They shall be detector check valve style or of some other non-intrusive style.

404.10 Town's main water supply strainer

404.10.1

Where strainers are required on a town's main each strainer shall be designed:

(a) To provide at least 25 mm^2 screen open area for each litre per minute of design flow, and not less than four times the cross sectional area of the supply pipe;

(b) With each orifice at least 1 mm smaller than the smallest sprinkler head or sprayer orifice used in the system which does not itself have a fitted strainer;

(c) To enable removal of the screen for cleaning;

(d) To be protected against corrosion.

404.10.2

Each strainer shall be installed on the connection from the town's main upstream of any combined main check valve or backflow prevention unit, and any fire pump preferably within, or directly adjacent to, the respective control valve or fire pump enclosure.

A1

404.10.3

A pressure gauge shall be fitted immediately upstream of the strainer.

404.11 Hazardous processes and explosion hazard – Special precautions concerning pipework, valves and the like

In buildings or sections of premises in which particular hazardous processes are carried out or conditions exist which are liable to result in explosions:

(a) No sprinkler control valves shall be located within 6 m of such premises;

(b) There shall be arrangements whereby the sprinkler protection in the hazardous area may be quickly and independently shut down in the event that an explosion demolishes the mains within, or close by, the building. This shall be done in one of the following ways:

    (i) The hazardous area shall be protected by an installation that does not also protect a non-hazardous area
    (ii) The hazardous area shall be protected by an installation protecting non-hazardous buildings. In such cases, the sprinklers in the hazardous protected area shall be fed by a separate main distribution pipe connected to the remainder of the installation immediately downstream of the alarm valve. A subsidiary stop valve located within the control valve enclosure shall be fitted to this main
    (iii) The hazardous area shall be protected by an installation that also protects non-hazardous areas. A separate connection to supply the hazardous area shall be made to a distribution pipe within the non-hazardous building at a point downstream of the last range supplied by that distribution pipe. At floor level, but within 3 m radially of the point of connection, there shall be an automatic pressure control valve and, immediately upstream of that, a subsidiary stop valve. All valves shall be readily accessible and in a well lit position:
        (A) The pressure control valve shall be arranged to close down in the event that the flow through it exceeds 150 % of the design flow in the hydraulically most favourably placed assumed area of operation in the hazardous building
        (B) Very careful attention is needed in setting the operating pressure of the automatic valve. The operating pressure shall be specifically approved. Adequate means of checking and testing its operation and pressure setting shall be provided
        (C) Prominent reference to the existence and location of the automatic valve and subsidiary stop valve shall be incorporated on the block plan;

(c) Sprinkler water supply pipes shall not be carried within these buildings or any locations subject to damage following collapse after an explosion;

(d) Water supplies, such as pressure tanks or gravity tanks shall not be housed therein.

405 ENHANCED SAFETY VALVE SET

Enhanced safety valve sets are designed to allow the alarm valve to be serviced without decommissioning the sprinkler system, or isolating the FBA. They also allow for increased floor areas per valve set, subject to conditions specified in 302.1.5. See 211.3.

An enhanced safety valve set shall consist of the following components:

(a) Normally open stop valves shall be fitted both upstream and downstream of the alarm valve. Both valves shall be locked and labelled and supervised in accordance with 404.2.4 and 404.2.5 as subsidiary stop valves, through the subsidiary stop valve isolation device, to allow authorised closing of the valves without isolation of the FBA. A durable label shall be fitted to the inside of the FBA cabinet door noting that the main stop valves are supervised through the subsidiary stop valve isolation switch;

(b) The fire brigade alarm, installation pressure gauge, fire sprinkler inlet and any pump start lines shall be connected downstream of the second (downstream) stop valve;

(c) A bypass, of the same size as the main alarm valve, shall be fitted around the control valves. This shall incorporate:

  (i) A drip tight check valve in the case of Type X systems or a second alarm valve in the case of Type Y systems
  (ii) Locked and labelled, normally closed, supervised stop valves, both upstream and downstream of the check or alarm valve
  (iii) The supervised stop valves shall give a DEFECT signal when opened by more than two turns of the hand wheel
  (iv) For Type Y systems the hydraulic gong outlet shall be piped to the retard chamber, to give a rise in pressure alarm in accordance with 407.2.2.2. Check valves shall be installed on both gong outlets, to provide separation between alarm valves;

(d) The super pressure pump or Type Y bypass shall be piped to downstream of the second (downstream) main stop valve;

(e) Clear testing, maintenance and isolation procedures, as agreed to by a SSC, shall be provided in a durable form and displayed in a conspicuous position adjacent to the control valves;

(f) A durable sign shall be mounted on the alarm valve as follows: “DO NOT CLOSE main stop valve. In the case of sprinkler activation or for service work use appropriate floor or sectional isolation valve – see block plan”.

A schematic diagram of this arrangement is shown in figure 4.5.

NOTE – To maintain the enhanced safety features of these systems, it is important that service and maintenance personnel are familiar with this type of valve set when working on the installation. The water supplies and FBA functions should remain as fully operational as possible at all times.

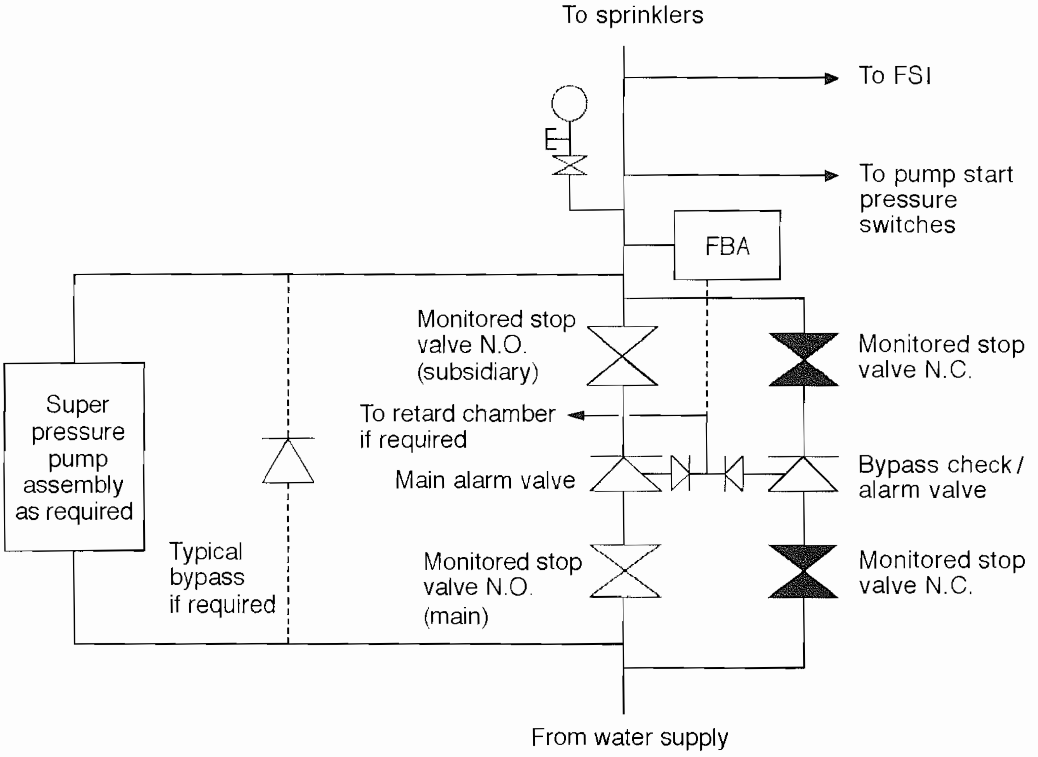

To sprinklers
To FSI
To pump start pressure switches
FBA
Super pressure pump assembly as required
Typical bypass if required
Monitored stop valve N.O. (subsidiary)
To retard chamber if required
Main alarm valve
Monitored stop valve N.O. (main)
Monitored stop valve N.C.
Bypass check / alarm valve
Monitored stop valve N.C.
From water supply

Figure 4.5 – Enhanced safety valve set arrangement

406 PRESSURE GAUGES

406.1

Each installation shall be fitted with an installation gauge which indicates the pressure above the alarm valves, and a fire brigade alarm (FBA) gauge which indicates the pressure on the FBA release mechanism.

406.2

Each system shall be fitted with a gauge indicating the pressure on the upstream side of each water supply back pressure valve.

406.3

The section of pipe immediately upstream of the main stop valve shall be fitted with a gauge indicating the single or combined main supply pressure.

406.4

Pressure gauges shall comply with the requirements of BS 1780, DIN 16005 or other equivalent Standard, shall be marked in kPa, and be not less than 90 mm nominal size.

406.5

The maximum scale value shall be of the order of 150 % of the known maximum pressure. All gauges downstream of the alarm valve shall have the same calibration and maximum scale value. All water supply gauges shall have the same calibration and maximum scale value except pump suction gauges.

406.6

Pressure gauges shall be calibrated with divisions not exceeding:

20 kPa for maximum scale values ≤ 1000 kPa
50 kPa for maximum scale values > 1000 ≤ 1600 kPa
100 kPa for maximum scale values > 1600 kPa.

406.7

The negative pressure section of compound suction gauges shall have divisions not exceeding 20 kPa.

406.8

All pressure gauges shall be neatly and permanently labelled as to their purpose in such a manner that there is no possibility of the label fading, becoming detached from the gauge or fouling the operation of the gauge.

406.9

Special requirements for the location and marking of pressure gauges for fire sprinkler inlets are set out in 610.5.3.

406.10

A means of isolating a gauge shall be provided immediately below each gauge.

406.11

A permanent plugged fitting shall be provided between any normally pressurised gauge and the gauge isolation valve to allow the attachment of a test gauge.

407 ALARM DEVICES

Every installation shall include, adjacent to the sprinkler valves, both an hydraulic water flow alarm and a fire brigade alarm. An installation may also include a connection to an evacuation alarm and to flow switch indicators.

407.1 Hydraulic water flow alarms

407.1.1 *General*

The following requirements apply:

(a) The water flow alarm shall be a listed hydraulic gong, which detects and locally notifies water flow through the alarm valve;
(b) The gong shall be located outside the building as close as possible to the alarm valve. It shall be painted red and bear the words “FIRE SPRINKLER ALARM” in contrasting letters;
(c) The water flow alarm shall not cause any signal to be transmitted to the fire brigade, except in the case of Type Y signalling.

407.1.2 *Hydraulic gong*

The following requirements apply:

(a) *Method of operation.* The device shall be actuated by the lifting of the alarm valve permitting water to flow to an hydraulic motor which directly operates the sounder;
(b) *Pipework.* The pipework shall comply with the listing requirements of the gong. The gong drain shall not be interconnected with the system drain except via an air gap;
(c) *Testing.* Means shall also be provided to permit testing of the gong without lifting the alarm valve;
(d) *Number.* Where there is more than one installation and the alarm valves are grouped together, one gong may serve two or more sets of control valves. Where there is more than one gong, each gong shall be numbered according to the installation it serves.

407.2 Fire brigade alarm

407.2.1 *General*

The type of fire brigade alarm (FBA) shall be determined by the maximum water supply pressure, measured at the alarm valve and downstream of any pressure reducing valve, in any water supply in relation to the highest design pressure and the pressure rating of sprinkler system components.

A1 The fire brigade alarm shall comply with 407.2.2.1 (Type X) where one of the following applies:

(a) The maximum water supply pressure does not exceed 800 kPa;
(b) The sprinkler system components have a maximum working pressure higher than 1200 kPa;
(c) The system is dry-pipe, pre-action or deluge; or
(d) The system requires a pump to achieve the design pressure at the design flow and the normal (unboosted) pressure of the water source when measured at the alarm valves does not exceed the highest design pressure by at least 140 kPa.

Where the maximum water supply pressure exceeds 800 kPa and the sprinkler system components have a maximum working pressure of 1200 kPa the fire brigade alarm shall comply with 407.2.2.2 (Type Y).

NOTE –
(1) A diagram of a wet pipe control valve showing an acceptable arrangement for Type X signalling is given in figure 4.6.
(2) A diagram of a wet pipe control valve showing an acceptable arrangement for Type Y signalling is given in figure 4.7.
(3) A diagram of a dry pipe control valve showing an acceptable arrangement of signalling (see 407.2.2.1(b)) is given in figure 4.8.

407.2.2 *Types of fire brigade alarm*

407.2.2.1 *Type X*

Fire brigade alarm Type X shall be a listed device which interfaces to hydraulic connections to the sprinkler installation and to external alarm signal transport wiring and which:

(a) Detects, and is activated by, a drop in pressure in the installation and initiates an alarm signal. It shall be capable of detecting three different pressure states known as “NORMAL”, “DEFECT”, and “FIRE”;

NOTE – Where the brigade receiving equipment does not incorporate a facility to detect three different alarms states, or where the fire brigade alarm is not connected to the fire brigade receiving equipment, the requirement in (a) above for a “DEFECT” signal may be deleted.

(b) Generates, in the case of a dry pipe, pre-action or deluge system the various alarm states by either a drop in pressure or a rise in pressure or by a combination of the two and shall be subject to approval;

(c) Detects, and signals in the manner of a “FIRE” call, unauthorised activation of supervisory devices on main and subsidiary stop valves. Authorised closure shall necessitate the transmission of a signal other than “NORMAL” or “FIRE” where the equipment has that capability;

(d) Consists of a lockable cabinet enclosing pressure sensor(s), signal generating devices and labelled isolation switches as required and, if no suitable alternative is provided, a space for the testing record book;

(e) Includes listed pressure sensors that:

   (i) Are pressurised through a pipe incorporating a drilled check valve, pressure gauge and test valve (piped away to a suitable location) arranged to permit the operating pressures of the pressure switches to be accurately set and subsequently checked

   (ii) For wet installations are set and connected to the signal generating device such that a "FIRE" signal is generated at approximately 140 kPa above the highest supply pressure. A "DEFECT" signal (if provided) shall be generated approximately 140 kPa above the fire pressure sensor setting and at pressures higher than that of a "NORMAL" signal shall be generated. The installation pressure shall be no less than 140 kPa above "DEFECT" pressure. The actual settings shall be approved
   (iii) Have different differentials for dry pipe, pre-action and deluge systems as may be appropriate. The settings shall also be approved;

(f) Includes a signal generating device of a listed type and, where it is connected to the fire brigade receiving equipment, it is also authorised for use by the New Zealand Fire Service.

Stop valves are not permitted in pipes connected to pressure switches.

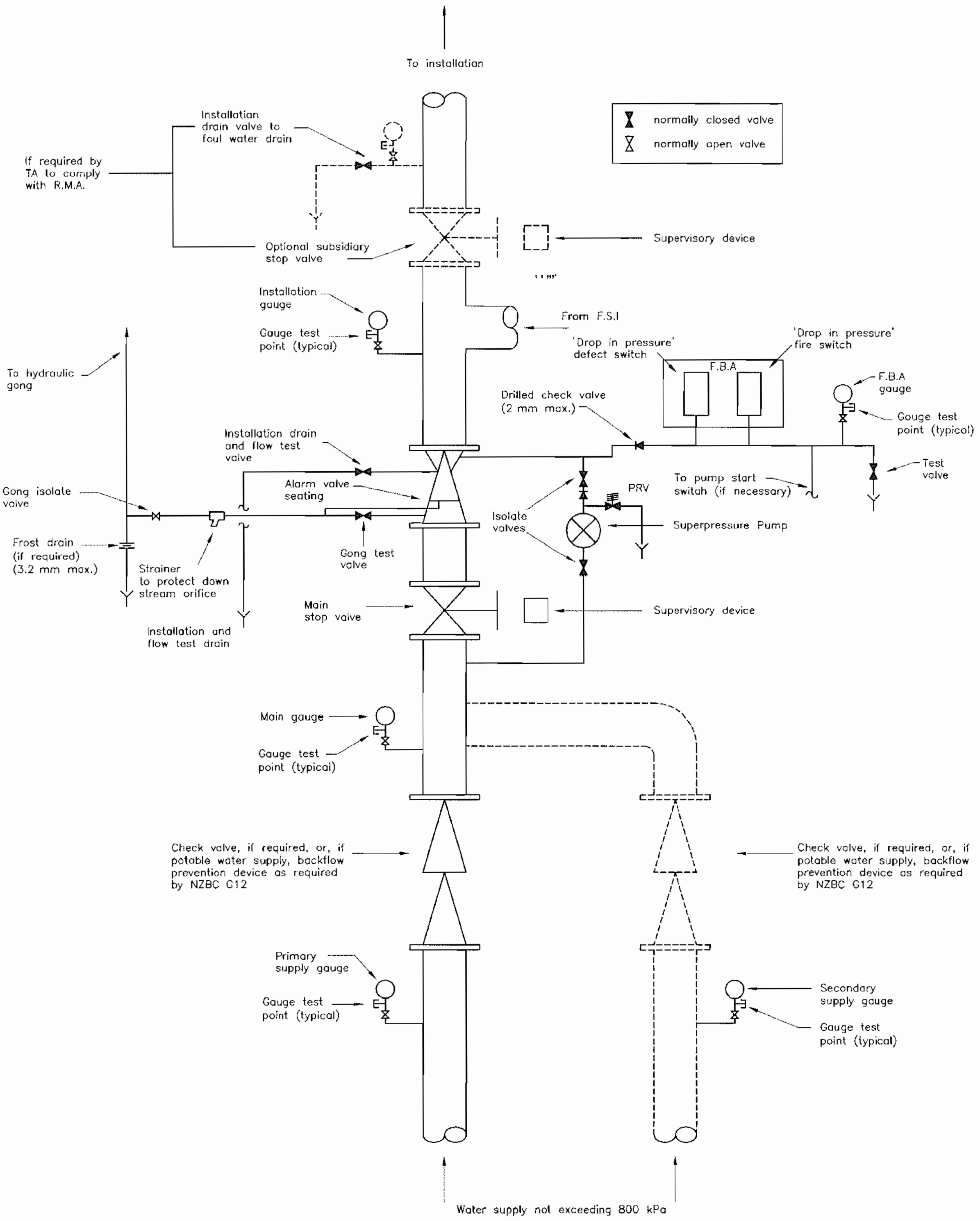

To installation
Installation drain valve to foul water drain
If required by TA to comply with R.M.A.
normally closed valve
normally open valve
Optional subsidiary stop valve
Supervisory device
Installation gauge
Gauge test point (typical)
From F.S.I
'Drop in pressure' defect switch
'Drop in pressure' fire switch
F.B.A
F.B.A gauge
Gauge test point (typical)
To hydraulic gong
Drilled check valve (2 mm max.)
Installation drain and flow test valve
Alarm valve seating
Gong isolate valve
Test valve
To pump start switch (if necessary)
PRV
Isolate valves
Superpressure Pump
Frost drain (if required) (3.2 mm max.)
Strainer to protect down stream orifice
Gong test valve
Main stop valve
Supervisory device
Installation and flow test drain
Main gauge
Gauge test point (typical)
Check valve, if required, or, if potable water supply, backflow prevention device as required by NZBC G12
Check valve, if required, or, if potable water supply, backflow prevention device as required by NZBC G12
Primary supply gauge
Gauge test point (typical)
Secondary supply gauge
Gauge test point (typical)
Water supply not exceeding 800 kPa

Figure 4.6 – Wet pipe control valve showing an acceptable arrangement for type 'X' signalling complying with 407.2.2.1

NOTE –

(1) Backflow prevention devices require valves upstream and downstream for testing and maintenance purposes. If fit for purpose, the street valve and main stop valve may meet this need. Alternatively, additional supervised valves will need to be installed.

(2) This illustration is for guidance only. In the event of any disparity the requirements of the text of the Standard take precedence.

407.2.2.2 *Type Y*

Fire brigade alarms Type Y shall be a listed device which interfaces to hydraulic connections to the sprinkler installation and to external alarm signal transport wiring and which:

(a) Detects, and is activated by, a pressure rise in the hydraulic alarm gong line and also by a drop in pressure to 140 kPa above the highest installation design pressure required at the alarm valve. In the case of a rise in pressure in the gong line, the alarm shall be activated within 60 s of the lifting of the alarm valve seat. The equipment shall be capable of signalling two states known as "FIRE" and "NORMAL";

(b) Detects and signals in the manner of a "FIRE" call, unauthorised activation of supervisory devices on main and subsidiary stop valves. Authorised closure shall necessitate the transmission of a signal other than "NORMAL" or "FIRE" where the equipment has that capability;

(c) Is arranged as shown in figure 4.7 and:

   (i) Has a lockable cabinet housing pressure sensor(s), signal generating devices, labelled isolation switches as required and, if no suitable alternative is provided, a space for the testing record book
   (ii) Additionally, provides protection against false alarms being generated via transient pressure surges. This requirement shall be achieved by either:
      (A) Providing a hydraulic retard system including the provision of one or more retard chambers installed in the gong line between the alarm valve and the gong valve, so sized and designed as to retard the rise in pressure as a consequence of transient openings of the alarm valve. The retard chamber shall incorporate a permanent drain and the drain, inlet pipe and chamber shall be so sized and designed as not to retard the transmission of a FIRE signal more than 20 s after the alarm valve lifts in response to one sprinkler head opening and the satisfactory operation of the gong, or
      (B) By providing an electronic retard system, including the installation of a listed pressure sensor, incorporated with an integral electronic time delay function, installed in the lockable cabinet described in (i). The gong line shall include a drain, complete with orifice to allow any trapped water to automatically drain
   (iii) A piped connection shall be provided in parallel and bypass the alarm valve. This bypass trim shall be of a size specified by, and use a check valve supplied by, the alarm valve manufacturer for this purpose
   (iv) Test devices (piped away to suitable locations) and pressure gauges shall be provided for both the rise in pressure and drop in pressure alarm functions and be labelled accordingly. These shall permit the operating pressures to be accurately set and subsequently checked. Generally, they shall be arranged as shown in figure 4.7 including orifices and check valves. Stop valves are not permitted in pipes connected to pressure switches. An inspector's test valve complete with orifice equivalent to the smallest sprinkler shall be installed to prove that single head flow will generate a fire call
   (v) Pressure sensors shall be of a listed type;

(d) Includes a signal generating device of a listed type and, where it is connected to fire brigade receiving equipment, is also authorised for use by the New Zealand Fire Service.

A super pressure pump may be fitted to the valve set trim to allow the installation pressure to be raised as a means of reducing false alarms. Where this pump is manually controlled its discharge rate shall be limited to ensure that single head flow generates a fire signal. The installation pressure shall not be raised above the pressure rating of the components installed in the sprinkler system.

NOTE – Type X systems generally provide better immunity to false alarm generation, when compared to Type Y systems. Most fire protection equipment has a maximum pressure rating of 1200 kPa. Some sprinkler heads, valves and pipe couplings are available with pressure ratings in excess of 1200 kPa. It is recommended that if the use of such equipment will avoid the use of Type Y alarms, that such equipment be used.

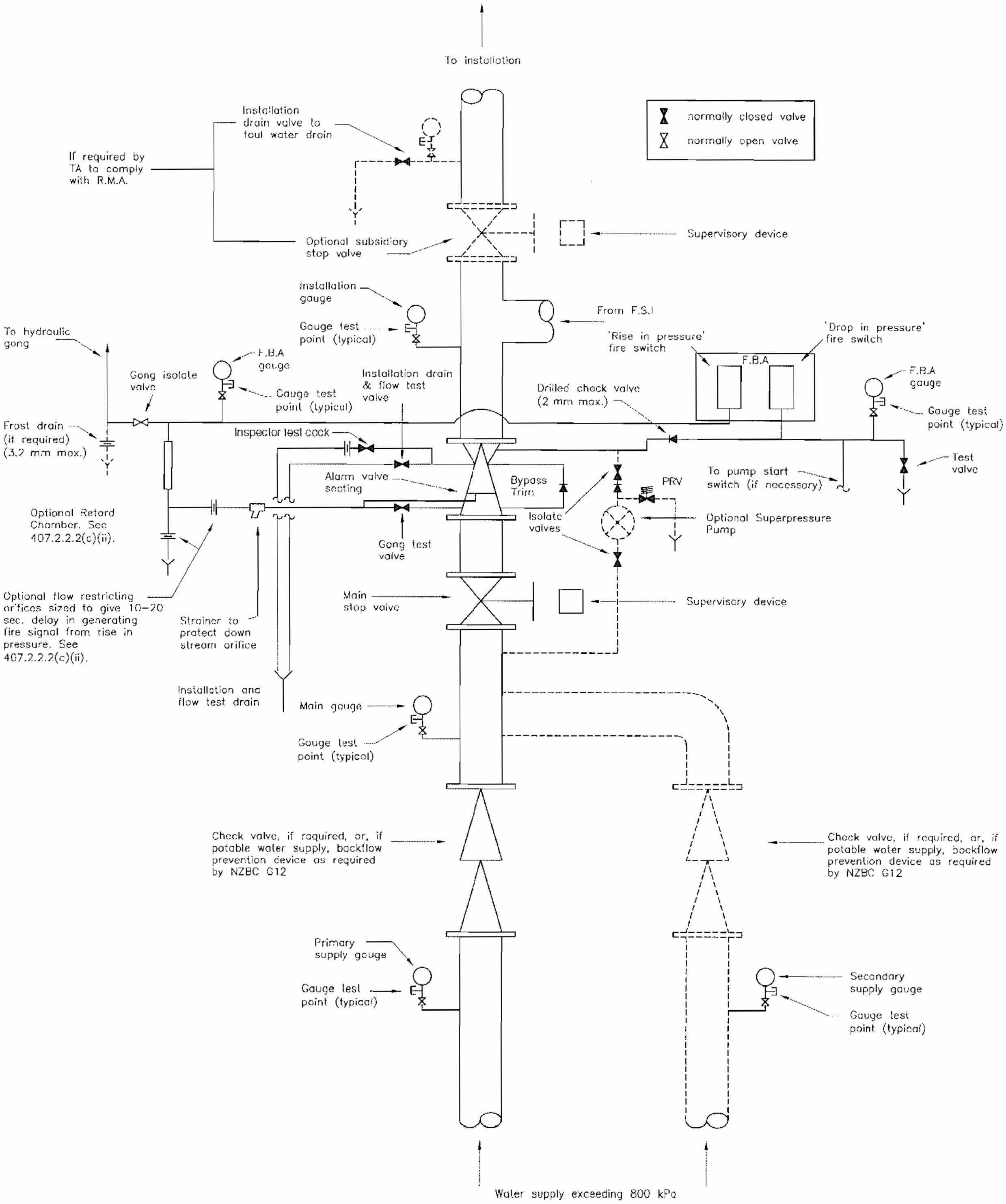

To installation
Installation drain valve to foul water drain
If required by TA to comply with R.M.A.
Optional subsidiary stop valve
normally closed valve
normally open valve
Supervisory device
Installation gauge
Gauge test point (typical)
From F.S.I
'Rise in pressure' fire switch
'Drop in pressure' fire switch
F.B.A
F.B.A gauge
Gauge test point (typical)
To hydraulic gong
Gong isolate valve
F.B.A gauge
Gauge test point (typical)
Installation drain & flow test valve
Drilled check valve (2 mm max.)
Frost drain (if required) (3.2 mm max.)
Inspector test cock
Alarm valve seating
Bypass Trim
PRV
To pump start switch (if necessary)
Test valve
Isolate valves
Optional Superpressure Pump
Optional Retard Chamber. See 407.2.2.2(c)(ii).
Gong test valve
Optional flow restricting orifices sized to give 10–20 sec. delay in generating fire signal from rise in pressure. See 407.2.2.2(c)(ii).
Strainer to protect down stream orifice
Main stop valve
Supervisory device
Installation and flow test drain
Main gauge
Gauge test point (typical)
Check valve, if required, or, if potable water supply, backflow prevention device as required by NZBC G12
Check valve, if required, or, if potable water supply, backflow prevention device as required by NZBC G12
Primary supply gauge
Gauge test point (typical)
Secondary supply gauge
Gauge test point (typical)
Water supply exceeding 800 kPa

Figure 4.7 – Wet pipe control valve showing an acceptable arrangement for type 'Y' signalling complying with 407.2.2.2

NOTE –

(1) Backflow prevention devices require valves upstream and downstream for testing and maintenance purposes. If fit for purpose, the street valve and main stop valve may meet this need. Alternatively, additional supervised valves will need to be installed.

(2) This illustration is for guidance only. In the event of any disparity the requirements of the text of this Standard take precedence.

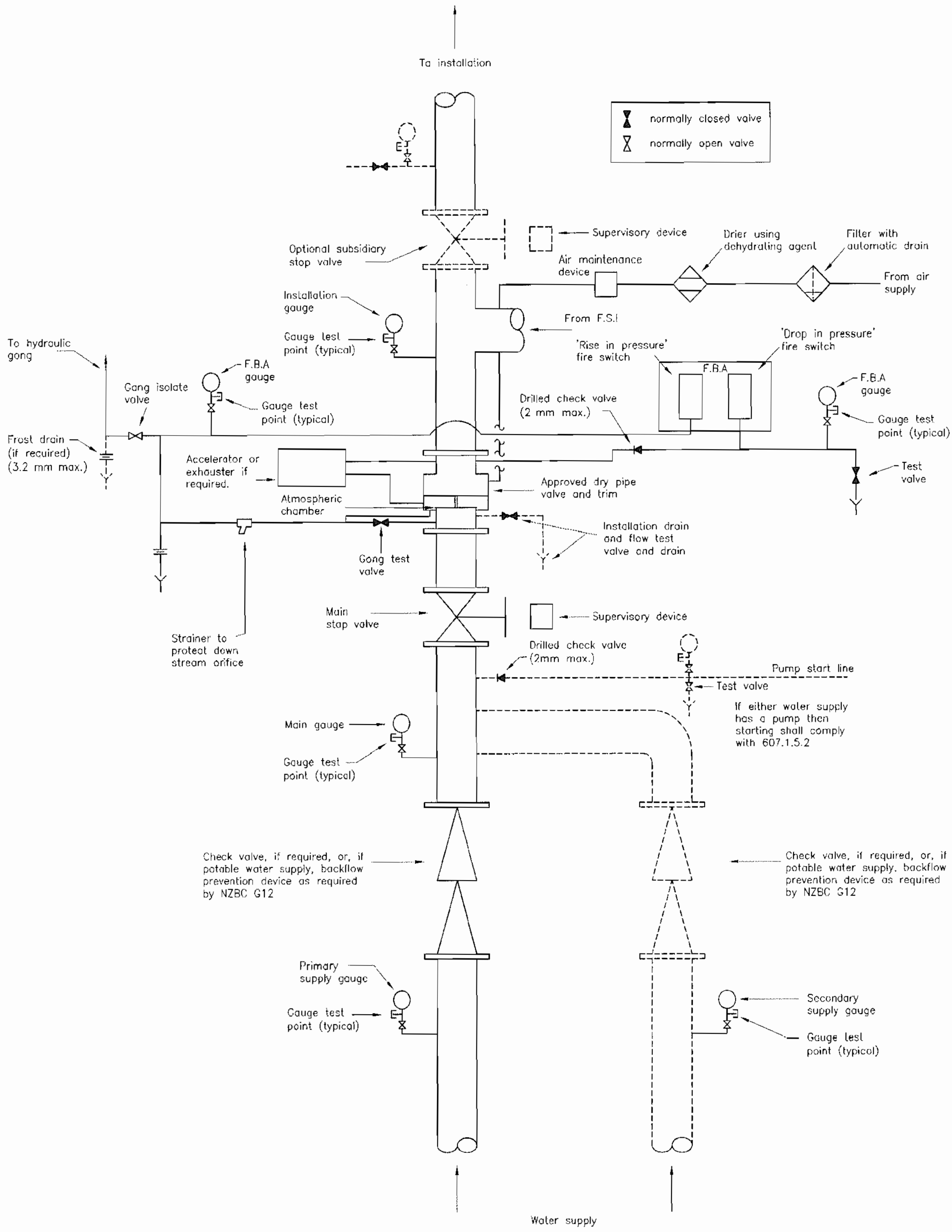

To installation
normally closed valve
normally open valve
Optional subsidiary stop valve
Supervisory device
Air maintenance device
Drier using dehydrating agent
Filter with automatic drain
From air supply
Installation gauge
From F.S.I
Gauge test point (typical)
'Rise in pressure' fire switch
'Drop in pressure' fire switch
F.B.A
To hydraulic gong
F.B.A gauge
Gong isolate valve
Gauge test point (typical)
Drilled check valve (2 mm max.)
F.B.A gauge
Gauge test point (typical)
Frost drain (if required) (3.2 mm max.)
Accelerator or exhauster if required.
Test valve
Approved dry pipe valve and trim
Atmospheric chamber
Installation drain and flow test valve and drain
Gong test valve
Main stop valve
Supervisory device
Strainer to protect down stream orifice
Drilled check valve (2mm max.)
Pump start line
Test valve
If either water supply has a pump then starting shall comply with 607.1.5.2
Main gauge
Gauge test point (typical)
Check valve, if required, or, if potable water supply, backflow prevention device as required by NZBC G12
Check valve, if required, or, if potable water supply, backflow prevention device as required by NZBC G12
Primary supply gauge
Gauge test point (typical)
Secondary supply gauge
Gauge test point (typical)
Water supply

Figure 4.8 – Typical dry pipe control valve arrangement

NOTE –

(1) Backflow prevention devices require valves upstream and downstream for testing and maintenance purposes. If fit-for purpose, the street valve and main stop valve may meet this need. Alternatively, additional supervised valves will need to be installed.

(2) This illustration is for guidance only. In the event of any disparity the requirements of the text of this Standard take precedence.

407.2.3 *Connection to the fire brigade*

The fire brigade alarm shall be transmitted automatically to an alarm service monitoring provider contracted to the New Zealand Fire Service to monitor private alarms. Transmission may be via dedicated data circuits (whether multiplexed or not) or via data-over voice circuits where digital packet networks facilities are available. "Fire" signals shall be annunciated automatically, either in a manned Fire Service control room, or cause automatic activation of mobilising alarms at an unmanned fire station. "Normal", "defect", "isolate" and other supervisory alarms shall be annunciated either at the same place as the "fire" signal or at some other location provided that procedures exist to promptly initiate appropriate action in response to such signals and provided that the Fire Service can exercise control over, and have means of monitoring the correct performance of such procedures.

407.2.4

A SSC may determine that due to distance, or the absence of suitable receiving equipment, or an adequate signalling path, connection of the fire brigade alarm to brigade receiving equipment is not required, it shall require in its place:

(a) A locally operated general alarm which shall normally be audible over a 1 km radius;

(b) Evidence of a suitably trained person to be available to respond to the alarm at all times;

(c) The power supplies for such alarm to be from an extremely reliable source.

407.2.5 *Fire brigade alarm (FBA) power supply*

The power supply for the FBA shall be via a listed device dedicated to or incorporated in the FBA and complying with the relevant requirements of NZS 4512.

407.3 Evacuation alarms

407.3.1 *General*

Where a sprinkler protected building is fitted with a system of evacuation alarms, the sprinkler installation may be connected in such a way as to cause the evacuation alarms to operate on activation of the fire brigade alarm fire signal. This connection shall not cause the system of evacuation alarms to transmit a signal to the New Zealand Fire Service.

If such a facility is fitted, an external evacuation sounders cut off switch shall be mounted on the fire brigade alarm cabinet. Operation of this switch shall generate a "DEFECT" signal.

While this Standard does not mandate the interconnection of sprinkler installations with evacuation alarms, it is anticipated that normal practice would be to ensure that the building is partially or completely evacuated on sprinkler activation.

407.3.2 *Testing*

The connection to the evacuation alarm shall be made in such a way as to permit both the evacuation alarm alerting devices and the sprinkler system to be isolated or rendered inoperative without the need to isolate or render inoperative the other system. All alerting devices activated by the fire sprinkler system shall be isolated by a switch located in the cabinet described in 407.2.2.1(d) or 407.2.2.2(c)(i), as applicable.

407.4 Flow switch indication

In certain cases, this Standard requires flow switches to provide indication of the section of the sprinkler installation which is operating (see 211.5). Flow switches shall be listed. Flow switches shall incorporate a test facility with orifice size not greater than the smallest nominal sprinkler or nozzle orifice used in that part of the sprinkler installation and this shall discharge via fixed pipework into a permanent drain. The valves controlling the test facility shall be labelled and strapped in the closed position.

NOTE – To ensure that the flow through this assembly will allow the flow switch to be tested, the drain pipework will require to be adequately sized.

Flow switches shall not be installed in series, in combination with Boolean logic to determine which section of a sprinkler installation has operated.

Flow switch indicators shall not be used to generate a signal to the fire brigade.

407.5 Super-pressure pump

In any sprinkler system that contains a Type X fire brigade alarm (see 407.2.2.1) there shall be installed an electrically driven super-pressure pump that can be connected to each Type X installation so that the water pressure in the installation can be raised to a minimum of 100 kPa above the system's designed standing pressure.

The super-pressure pump shall be connected to the sprinkler installation downstream from the alarm valve through a normally closed drip-tight isolation valve.

A pressure relief valve shall be fitted between the pump and the isolation valve. It shall be set to limit the maximum pump output pressure to 100 kPa above the system's designed standing pressure.

It is recommended that an isolation valve be fitted on the input side of the pump to enable the pump to be removed for service. One of the two valves on this system shall provide backflow prevention capability when open or alternatively a non-return valve may be fitted.

The super-pressure pump may be positive displacement or roto-dynamic (centrifugal). The pump electric motor shall be fitted with a thermal overload switch. If not hard wired, a power outlet must be installed adjacent to the pump.

In single storeyed extra light hazard occupancies with less than 250 sprinklers, a manual pump may be installed as an alternative to an electrically driven pump.

NOTE –

(1) The super-pressure pump should be sized to pump the sprinkler system from the highest no-flow delivery pressure of the water supply up to the installation standing pressure in a period not exceeding 1 hour.

(2) In the case of antifreeze and tail-end antifreeze systems the super-pressure pump for the antifreeze component of the installation shall be sized to fill the installation and charge it up to its standing pressure in a period not exceeding 1 hour.

408 STORAGE HEIGHT LIMITATION INDICATORS

408.1

Where there is a potential for storage to exceed the heights for which the system was designed, a SSC may require signs or other visual height indicators to be fitted which notify building occupants as to the maximum height of storage permitted and to warn against exceeding that height.

408.2

408.2.1

Hanging signs shall be of substantial sheet material marked on both sides. Unless approved otherwise by a SSC, signs shall be white with black lettering, with safety red and white arrows outlined in black, as shown in figure 4.9. They shall be at least 1.2 m wide and 0.8 m high. Safety red shall be shade No. 537 to NZS 7702 or 04 E 53 of BS 5252.

408.2.2

A SSC may approve alternative means of indicating storage heights, provided they give a clear and unambiguous indication of the maximum storage height permitted.

408.3

The bottom of signs or indicators shall be at the highest level to which the storage is permitted.

408.4

Such signs shall be installed to the satisfaction of a SSC at such spacing as to be readable from all points of the open floor and 90 % of any aisleways formed.

408.5

In cases where there is a single category of storage involved or where the racks or stacks are known to contain a mixture of goods of different categories, the wording shown in figure 4.9 shall be used based upon the most hazardous category.

Where there are, within one area, stacks or racks containing goods of a single category and other stacks or racks containing goods of another category, the wording and arrangement of signs shall be to the satisfaction of a SSC.

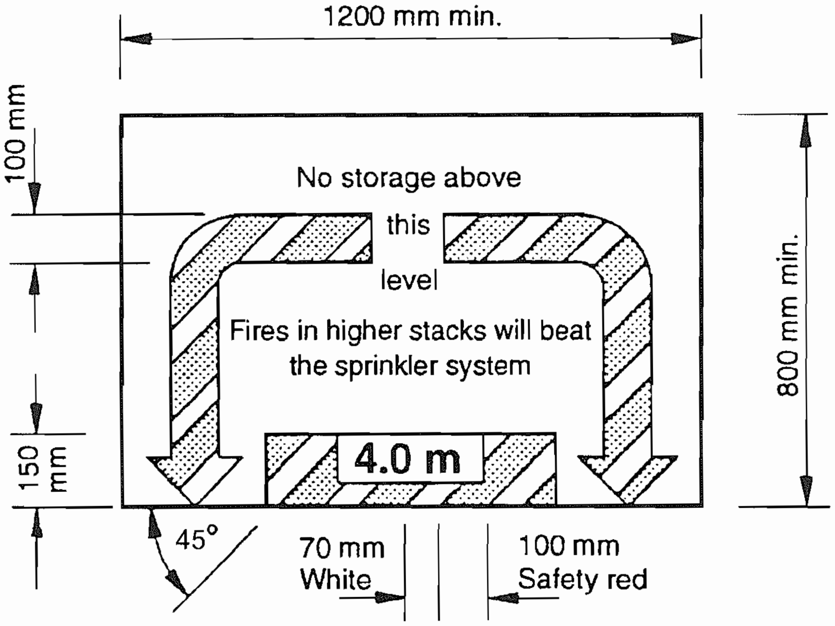


Figure 4.9 – Storage height limitation sign

NOTE – The height limitation shown in the figure, i.e. 4.0 m, is an example only. In use the actual height limitation appropriate to the situation will be shown.

409 AEROSOL WARNING SIGNS

409.1

Where levels 2 and 3 aerosol products, packaged in cartons, are stored or handled, a SSC may require signs to be fixed around areas of designated aerosol storage to notify building occupants that these products must be kept within the areas that have been designed to cope with this fire load.

409.2

Such signs shall be metal or substantial sheet material and shall be painted in White with Black lettering and the Safety Red circle (and slash) shall be outlined in Black, as detailed in Appendix L. Safety Red to be Shade No. 537 to NZS 7702 or 04 E 53 of BS 5252.

409.3

Such signs shall be installed to the satisfaction of a SSC at such spacing as to be readable from all points approaching the designated area and from 90 % of any aisleway within the designated area. Prohibition signs shall be positioned on all storage racks or storage areas immediately adjacent to the designated aerosol storage area.

410 FIRE DOORS

Fire doors installed in accordance with 205 shall be kept closed when not in use, and shall be self closing or close automatically upon detection of fire immediately adjacent to unprotected side of the fire door.

Automatic closing shall be achieved by either:

(a) A fusible link mechanically releasing the door closure mechanism; or

(b) The activation (release) of a magnetic door hold open device, via a signal from the fire brigade alarm, by way of a sprinkler head installed for detection purposes only, on the unprotected side of the doorset. This activation may be additional to other control requirements of the doorset, and does not preclude activation by other building fire safety systems.

NOTE – Magnetic hold-open devices should be installed at the same level of the self-closing devices. If the devices are at different levels there is a possibility that timber doors will warp due to the opposing forces being applied to the door.

Part 5
LOCATION OF SPRINKLERS

501 GENERAL

501.1

Clauses 501 to 517 do not provide guidance for the installation of suppression mode or control mode specific application sprinklers. The installation requirements for these sprinklers are provided in 518 and 519 respectively. Also some of these clauses are superseded by 520 in respect of ECOH and ECLH sprinklers.

Sprinklers may be located under beams or in bays or a combination of both, provided the locations meet the provisions outlined generally in 501.2.

501.2

In addition to meeting the limitations specified for the maximum area coverage per sprinkler and the maximum distance between sprinklers they shall be so located that there will be minimum interference to the discharge pattern by structural members such as beams, columns, girders and trusses or any other obstructing feature. Also sprinklers shall be located at the appropriate distance below ceiling and beams as required in 503.

NOTE – For further information on measurements converted to metric values see 102.

502 WALLS AND PARTITIONS

502.1

Except as provided for in 504 and 510, the distance of sprinklers from walls and partitions shall not exceed half the maximum allowable distance between sprinklers or half the design spacing whichever is the less (see figure 5.2).

502.2

Where an external wall is omitted, the distance of sprinklers from the outer edge of the roof or ceiling structure shall not exceed half the design spacing (see figure 5.1).

502.3

No sprinkler shall be placed with its axis closer than 50 mm from a window, wall, partition or beam, except horizontal sidewall sprinklers mounted through the wall or beam.

503 CEILINGS AND ROOFS

503.1 Distance of sprinklers below ceiling

Sprinklers shall be positioned below the underside of ceilings, roofs or equivalent surfaces in accordance with the listing details for the sprinkler.

If there are no specific limitations described within the listing, the centre line of the heat activated element shall be located not greater than 150 mm below the underside of any ceiling, roof or equivalent surface. Under the following circumstances, this distance may be increased up to the maximums shown below.

(a) Continuous structural or architectural members contiguous with the ceiling, roof or equivalent surface above, running in two directions, forming bays of area:

  (i) Not greater than 30 m^2 .... 450 mm
  (ii) Greater than 30 m^2 but less than 100 m^2.. 350 mm

(b) Continuous structural or architectural members contiguous with the ceiling above, running in one direction only:

  (i) At spacing on centres not greater than 900 mm .... 450 mm
  (ii) At spacing on centres greater than 900 mm but less than 2,300 mm .... 350 mm

(c) Not withstanding (a) and (b) above, 150 mm below the underside of any continuous structural or architectural members, contiguous with the ceiling, roof or equivalent surface above (see figure 5.1).

NOTE – The above requirements do not apply to residential, ECOH, suppression mode and control mode specific application sprinklers.

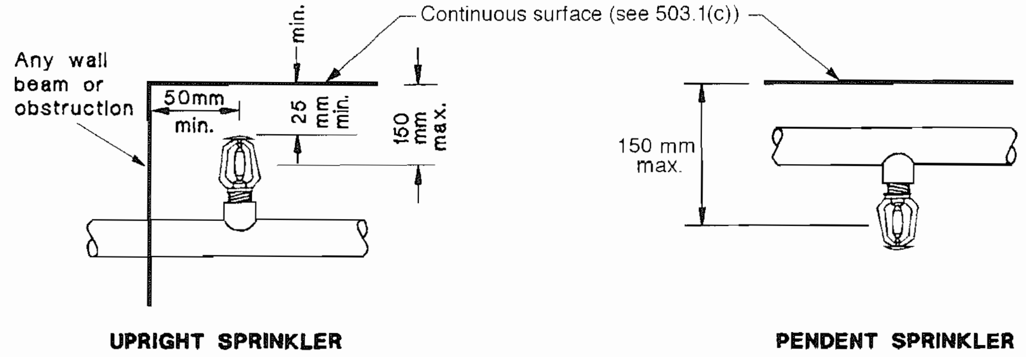
The placement of sprinklers below any ceilings, roofs or equivalent surfaces that do not conform to the above criteria shall be specifically approved. In determining acceptance, a Sprinkler System Certifier (SSC) shall consider whether the speed of detection is slower than would be the case with one of the options detailed above.

503.2

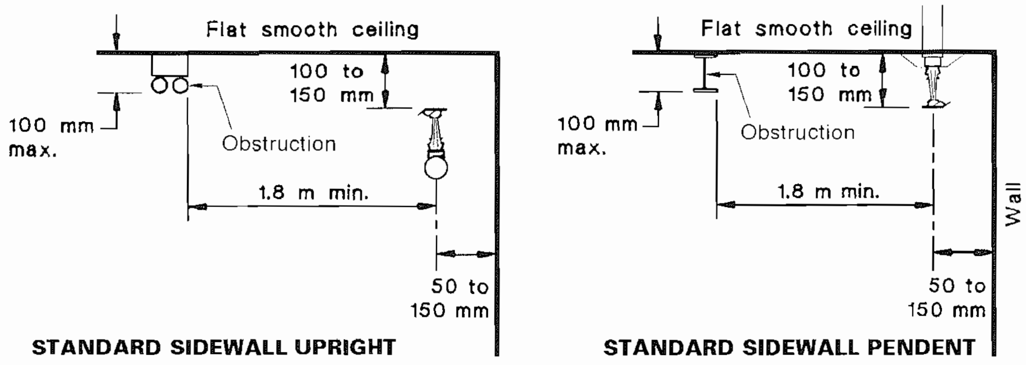
Deflectors of sprinklers shall be parallel to the slope of the ceiling, roof or incline of stairs. Sprinklers installed upright shall have at least 25 mm clearance between their deflectors and any plane surface directly above them (see figure 5.1).

503.3

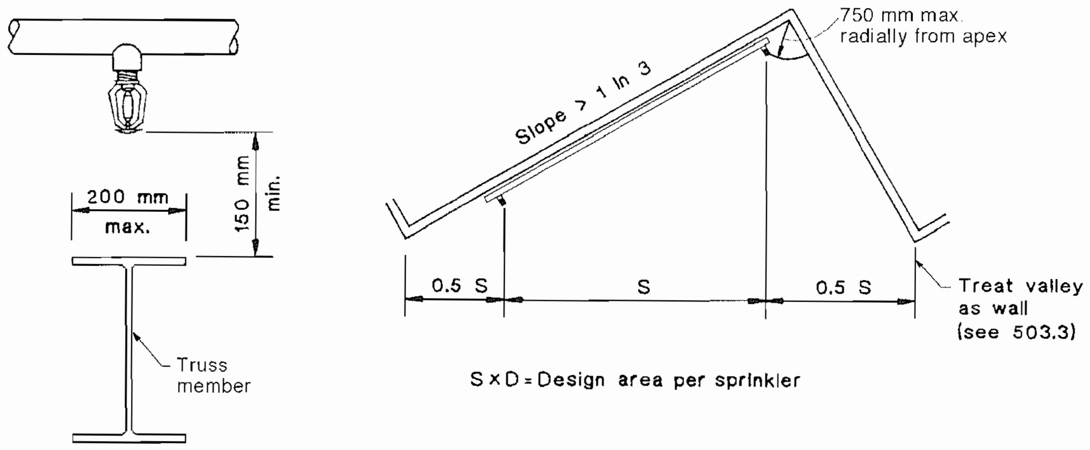
Where both the slopes are greater than one in three, a line of sprinklers shall be fixed at the apex unless there is a row of sprinklers not more than 750 mm distant radially therefrom. The valley at the intersect of the projection of such roof slopes shall be deemed to be the line of a wall for the purpose of 502.1 (see figure 5.1).



(a) Distance below ceiling – See 503.1



(b) Location of standard sidewall sprinklers – see 510.1.1


200 mm max.
150 mm min.
Truss member
750 mm max. radially from apex
Slope > 1 in 3
0.5 S
S
0.5 S
Treat valley as wall (see 503.3)
S x D = Design area per sprinkler

(c) Open roof trusses – see 508.2

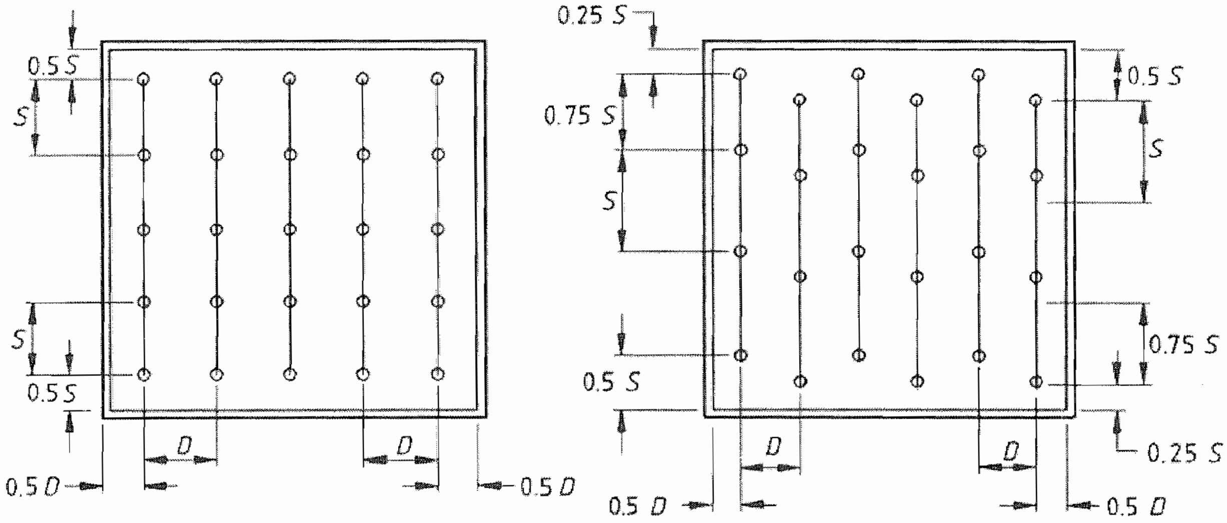
(d) Sloping ceilings – see 503.3and 505.2

Figure 5.1 – Positioning of sprinkler heads

504 STAGGERED SPACING

504.1

Where sprinklers are required to be staggered, the arrangements should be uniform, as indicated in figure 5.2. The distance from the end sprinkler to the wall or partition in each alternate row shall be not more than one-fourth of the maximum design spacing down the row and the spacing of the next sprinkler in the same row shall be not more than three-fourths the maximum design spacing (see table 5.1).



Standard spacing

Staggered spacing

Figure 5.2 – Spacing arrangements – Standard and staggered

Table 5.1 – Spacing arrangements – Standard and staggered

Hazard classification	**Standard spacing**		**Staggered spacing****		***S* x *D* max.** (m)
	S* max. (m)	***D* max.*** (m)	***S* max.*** (m)	***D* max.*** (m)	
Extra light:					
10 mm heads	4.6	4.6	–	–	21
15 mm heads	4.6	4.6	–	–	21
Ordinary	4.0	4.0	4.6	4.0	12
Extra high***	3.7	3.7	–	–	9 or 12

* *S* = Design spacing of sprinklers on range pipes
D = Distance between adjacent rows of sprinklers
** For spacing to end walls see 504.1
*** See 904.1.5 and 904.1.6

505 POSITION OF SPRINKLERS

505.1

Unless otherwise listed, sprinklers shall not be spaced closer than 1.8 m apart except where intervening constructional features provide a satisfactory baffle or where special baffles as described below are installed, in order to prevent the first sprinkler operating and wetting adjacent sprinklers.

Baffles should be 200 mm wide and 150 mm high and be of a strong rigid material. They should be located between the sprinklers and arranged to baffle the actuating elements. When placed on range pipes, the top of the baffles should extend above the deflectors by 50 to 75 mm.

505.2

Where sloping ceilings or roofs are concerned, the spacing measurements shall be taken horizontally (see figure 5.1(d)).

506 VERTICAL OBSTRUCTIONS TO SPRINKLER DISCHARGE

506.1

Where sprinkler deflectors are above the level of the bottom of beams, joists, light fittings or ducts, the sprinklers shall either be at a sufficient horizontal distance (as defined by table 5.2), with regard to the relative levels of the deflector and base of the obstruction so as not to cause undue interference with the discharge pattern, or the obstruction treated as a wall or partition. Special requirements apply in relation to residential sprinklers (see 506.5) and sidewall sprinklers (see 510).

NOTE – Attention is drawn to the need to comply with 503.1.

Table 5.2 – Sprinkler distances from obstructions

Minimum horizontal distance from sprinkler to side of obstruction	Maximum height of sprinkler deflector above bottom of obstruction		Minimum horizontal distance from sprinkler to side of obstruction	Maximum height of sprinkler deflector above bottom of obstruction	
	Conventional sprinklers installed upright	Spray sprinklers (upright and pendent types) and conventional sprinklers installed pendent		Conventional sprinklers installed upright	Spray sprinklers (upright and pendent types) and conventional sprinklers installed pendent
(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
100	–	17	1000	90	415
200	17	40	1100	110	440
300	25	70	1200	135	460
400	34	100	1300	170	460
500	42	150	1400	200	460
600	51	200	1500	230	460
700	60	250	1600	265	460
800	68	300	1700	300	460
900	78	360	1800	340	460

(See illustration below)

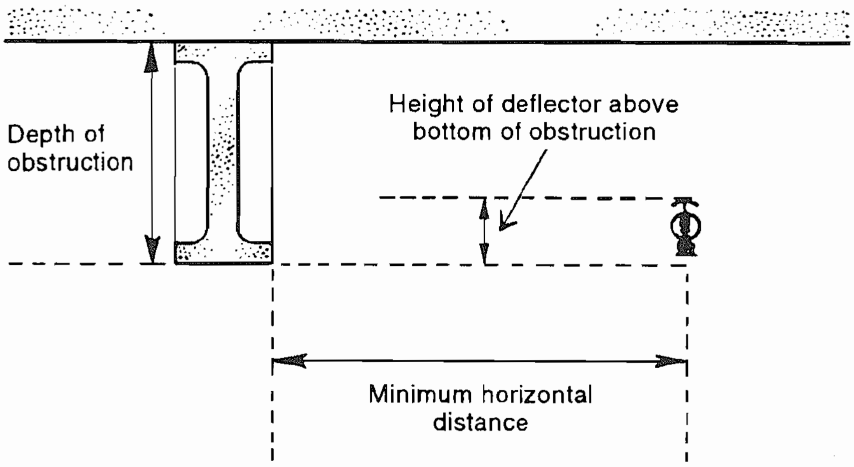

Depth of obstruction
Height of deflector above bottom of obstruction
Minimum horizontal distance

Figure 5.3 – Sprinkler distances from obstructions

506.2
Where the depth of the obstruction exceeds 300 mm (combustible ceilings) or 450 mm (non-combustible ceilings) and it is impracticable to position sprinklers at the required distance from the side of the beam, the beam shall be treated as a wall in relationship to the sprinklers in the adjoining bay.

506.3
Where the depth of beams or joists is such that the dimensions specified in table 5.2 cannot be complied with and the beams or joists are spaced closer than 1.8 m measured from centre-to-centre of beam, special consideration may be given to a relaxation if full particulars are submitted to a SSC. In such cases it will normally be a requirement that the sprinklers be staggered.

NOTE – Where beams of the above depth are spaced closer than 1.2 m, they should be underdrawn with substantial noncombustible material.

506.4
Where the top flange of a beam does not exceed 200 mm nominal width, sprinklers may be located directly over the beam, provided the sprinkler deflectors are at least 150 mm above the top of the beam (see figure 5.1 (c)).

506.5
Where residential sprinklers are installed the listing data specified by the manufacturer shall be complied with. Where such data is not part of the listing the requirements of table 5.3 and figure 5.4 shall apply.

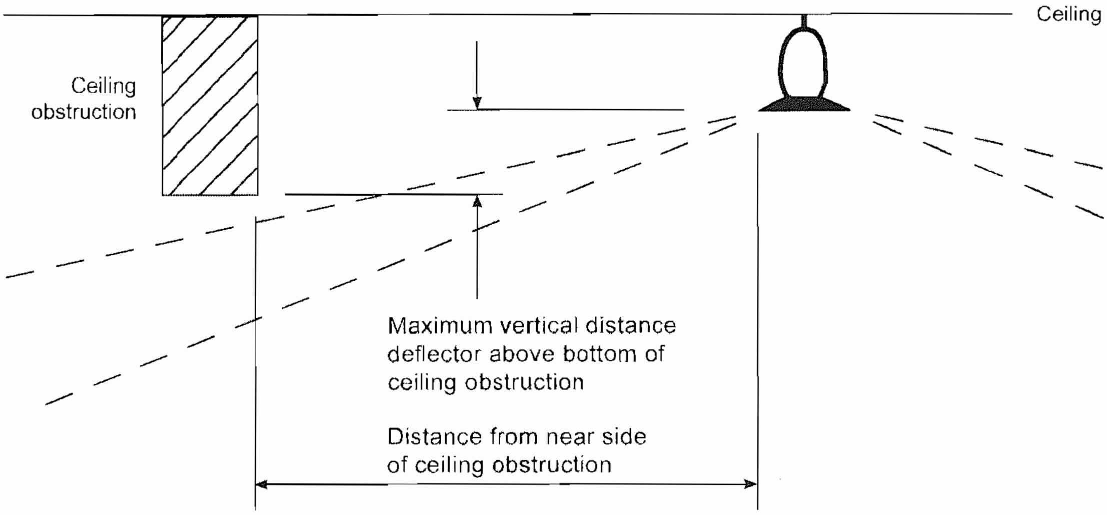

Ceiling
Ceiling obstruction
Maximum vertical distance deflector above bottom of ceiling obstruction
Distance from near side of ceiling obstruction

Figure 5.4 – Position of residential sprinkler deflector when located above the bottom of a ceiling obstruction

Table 5.3 – Maximum distance of residential sprinklers above bottom of ceiling obstruction (where not specified by manufacturer)

Horizontal distance from sprinkler to near side of ceiling obstruction (mm)	**Maximum vertical distance permitted (see figure 5.4)** (mm)
Up to 150	Not permitted
151 to 300	0
301 to 600	25
601 to 750	50
751 to 900	75
901 to 1050	100
1051 to 1200	150
1201 to 1350	175
1351 to 1500	225
1501 to 1650	275
1651 to 1800	350

506.6

Unless otherwise listed, where upright sprinklers are installed directly attached to pipework 100 mm or larger, they shall be installed on sprigs of a distance three times greater than the nominal pipe diameter, up to a maximum distance of 600 mm.

Upright sprinklers shall be installed at least 150 mm away from rod hangers and similar obstructions. They shall be installed with the frame arms parallel to the direction of pipe to which they are fixed.

507 COLUMNS

507.1

For obstructions such as columns, sprinklers shall be positioned away from obstructions a minimum distance of three times the maximum dimension of the obstruction. If the obstruction has a maximum dimension greater than 200 mm, sprinklers shall be located on opposite sides of the obstruction, with both sprinklers within half the design spacing from the obstruction.

508 OPEN ROOF TRUSSES

508.1

Sprinklers shall be at least 300 mm laterally from truss members which are 100 mm nominal width or less. Where trusses exceed 100 mm nominal width, the sprinklers shall be at least 600 mm laterally therefrom.

508.2

Where range pipes pass above or through trusses the sprinklers may be located on the centre line of the truss if the truss members are not more than 200 mm nominal width and the sprinkler deflectors are at least 150 mm above the truss member. When sprinklers are located alongside truss members, the distance of the sprinkler deflectors therefrom shall be in accordance with table 5.2 (see figure 5.1).

509 CLEAR SPACE BELOW SPRINKLERS

509.1

A clear space of at least 500 mm shall be maintained below the level of the sprinkler deflectors throughout the room. For high piled combustible stock, increased clearance of 900 mm or more shall be provided. Roof trusses shall at all times be accessible to water discharged from the sprinklers.

509.2

Where sloping ceilings or roofs are concerned, the storage of goods may follow the slope thereof subject to compliance with the above requirements.

NOTE –
(1) For concessions for bonded stores see 907.8.6.
(2) For maxima and minima for aerosol storage areas see 907.7.
(3) For requirements where control mode specific application sprinklers are used see 519.2.3.
(4) For requirements where suppression mode sprinklers are used see 518.3.4.

510 SPACING AND LOCATION OF SIDEWALL SPRINKLERS

510.1 Standard pendent or upright sidewall sprinklers

510.1.1 *Location*

The deflectors of standard sidewall sprinklers shall be located between 100 mm and 150 mm below the ceiling. The centre line of the sprinklers shall be between 50 mm and 150 mm from the face of the wall on which they are mounted. Deflectors shall be aligned parallel to ceilings and roofs (see figure 5.1).

510.1.2 *Spacing*

Maximum spacing along wall

Extra Light Hazard	4.6 m
Ordinary Hazard (combustible ceiling)	3.4 m
Ordinary Hazard (noncombustible ceiling)	3.7 m

Maximum spacing from end walls shall be half spacing along wall.

Maximum spacing across room, from wall to wall

Extra Light and Ordinary Hazard	3.7 m

510.1.3 *Sloping ceilings*

Where installed under a sloped ceiling (slope of greater than 1 in 12) sprinklers shall be located at the high point of the slope and positioned to discharge downward along the slope.

510.1.4 *Obstructions*

There shall be no obstruction at the ceiling within a rectangle extending along the wall 1 m on each side of the sprinkler and 1.8 m at right angles to the wall. Obstructions outside this rectangle shall meet the requirements of table 5.4.

Table 5.4 – Obstructions to standard sidewall sprinkler discharge

Depth of obstruction not exceeding (mm)	Minimum distance from sprinkler to obstruction	
	At right angles to wall (m)	Along wall (m)
100	1.8	1.0
125	2.1	1.2
150	2.4	1.4
175	2.7	1.6
200	3.0	1.8

510.2 Standard horizontal sidewall sprinklers

510.2.1 *Location*

The deflectors of horizontal sidewall sprinklers, unless otherwise listed shall be located between 150 mm and 300 mm below the ceiling. The base of the sprinklers shall be no more than 200 mm from the face of the wall on which they are mounted.

Spacing, sloping ceilings and obstructions to be as per 510.1.2, 510.1.3 and 510.1.4.

510.3 Extended coverage and residential horizontal sidewall sprinklers

510.3.1 *Location and spacing*

Sprinklers shall be located and spaced as required by the specific approved sprinkler head data sheet.

510.3.2 *Sloping ceilings*

Where installed under a sloped ceiling (slope of greater than 1 in 12) sprinklers shall be located at the high point of the slope and positioned to discharge downward along the slope.

510.3.3

There shall be no obstruction at the ceiling within a rectangle extending along the wall 2.44 m on each side of the sprinkler and 2.44 m at right angles to the wall. Obstructions outside this rectangle shall meet the requirements of ANSI/NFPA 13.

511 LOCATIONS OR CONDITIONS REQUIRING SPECIAL CONSIDERATION

511.1 Concealed spaces

511.1.1

Concealed spaces not exempted from sprinklering shall be sprinkler protected. The minimum design criteria shall be in accordance with the requirements for extra light hazard occupancies, namely, six sprinklers flowing at a minimum flow rate of 57 L/min each.

511.1.2

Where any part of a space below a ground floor is not exempted from sprinkler protection under 207 such part of the space shall be protected in accordance with the hazard classification.

511.2 Machinery pits and production lines

Machinery pits and the undersides of production lines, where waste may collect, shall be protected by sprinklers.

511.3 Hoists, lift shafts and enclosed chutes through floors

All hoists, lift shafts and chutes inside, or in communication with, sprinklered buildings otherwise than as permitted in 207 shall be protected by sprinklers. Sprinklers installed at the head of lift shafts shall be protected by listed guards.

511.4 Elevators, rope or strap races, gearing boxes and dust receivers

511.4.1

A sprinkler shall be fitted in the head of all seed and combustible product enclosed bucket elevators so that it can discharge down both legs of the elevator. Such sprinklers may be omitted from elevators which are less than 8 m high, have an internal cross section of each leg of less than 0.1 m^2 and do not penetrate any floor other than service platforms.

511.4.2

Sprinklers shall be fitted internally in all rope or strap races, gearing boxes and in all enclosed belt or shaft machine drives.

511.4.3

Sprinklers shall be fitted in dust cyclones, collection chambers and boxes where these are:

(a) Housed within the protected building;

(b) Erected outside and directly above the protected building unless the roof is of noncombustible construction;

(c) External to, but connected with and closely adjacent to the protected buildings.

Where dust cyclones, collection chambers and boxes are erected above noncombustible roofs or are situated remote from the protected building at least one sprinkler shall be fitted inside the trunking where it leaves the protected building.

511.4.4

In corn, rice, provender and oil mills:

(a) Sprinklers shall be fitted not more than 3 m apart inside all dust trunks which are more than 30° from the vertical and constructed of combustible materials;

(b) A sprinkler shall be fitted at the head of every dust trunk;

(c) When centrifugals or similar machines are placed one above another in tiers as in figure 5.5 and are less than 1 m from each other, sprinklers shall be fitted in the spaces as shown.

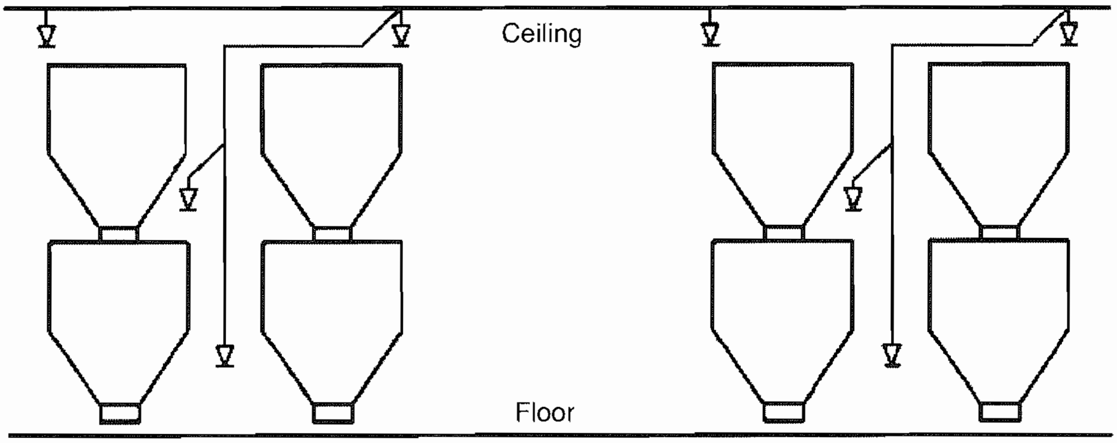


Figure 5.5 – Sprinkler positions for machines in tiers

511.5 Bins and silos

All bins and silos having a plan area in excess of 9 m^2 for the storage of flour, bran, or other similar material which has undergone any process of reduction (in such premises as flour mills, granaries, oil mills or distilleries), or for the storage of sawdust, wood flour, pulverised coal and similar easily ignitable materials which can be extinguished by water, shall be internally protected by sprinklers on the basis of one sprinkler per 9 m^2 of the bin or silo area. If the bin or silo contains material which will swell if wet, and thereby incur the risk of bursting, exemption from this rule may be allowed if full particulars are submitted to a SSC.

511.6 Escalators

Sprinklers shall be fitted under the escalator and in the escalator boot and motor space. Where limited space prevents this, sprinklers shall be fitted in any surrounding ceiling space immediately adjacent to the escalator, to the satisfaction of a SSC. These sprinklers shall be fitted regardless of the depth of the ceiling space.

511.7 Canopies, doorways and set back external walls

Any omission of sprinklers permitted by the following subclauses shall not override any requirement of 205.

511.7.1 *Canopies*

Sprinklers shall be installed under all canopies where goods are stored or handled and which communicate with the sprinkler-protected building. Canopies which are of noncombustible construction and do not extend more than 2.3 m from the wall of the building need not be fully protected provided that "cut-off" sprinklers are fitted under the canopy over each of the openings into the sprinkler-protected building. Where such openings do not exceed 2.5 m in width one sprinkler positioned centrally over each opening will suffice. Where openings exceed 2.5 m in width the sprinklers over the opening shall be spaced not more than 2.5 m apart and not more than 1.25 m from the sides of the opening.

In the case of verandahs and canopies covering walkways around the perimeter of a protected building, sprinklers will not be required over that portion of the walkway where:

(a) The walkway is constructed of concrete;

(b) There is no exposure created by other than any combustible elements of construction of the canopy; and

(c) The walkway is a footpath owned by the city corporation or is the subject of a lease requirement (which is observed) to the effect that the walkway has to be kept clear of any objects in the nature of storage, displays or otherwise.

NOTE – Furniture of the nature typically found in outdoor seating areas and the like will not be deemed to be a significant fire load. However, where goods such as combustible furniture are stacked for storage or displays, sprinkler protection should be required.

511.7.2 *Recessed doorways*

Where a building has recessed doorways where goods or refuse could be stored, such areas shall be sprinkler protected unless:

(a) A SSC agrees to the omission of such protection; or

(b) The ceiling of the doorway has a FRR of –/30/30, and the doorway does not exceed 800 mm in depth and 2 m in width.

511.7.3 *Set back external walls*

Where a part of an external wall is set back from the face of the building thereby forming a recess, sprinklers shall (except in the case of a doorway) be omitted from the exterior space thus formed only with approval which should be granted only where:

(a) It is clear that there cannot be any combustibles in the recess; and

(b) The walls and ceilings of the recess have not less than the FRR required by the Approved Documents for the New Zealand Building Code Fire Safety Clauses.

Recess depth (m)	≤0.6	>0.6 – 1.0	> 1.0 – 2.0	>2.0 – 4.0	>4.0
FRR	Nil	-/30/30	-/60/60	-/120/120	-/180/180.

511.7.4 *Residential decks and patios*

Sprinklers shall be provided over permanently covered residential patios, decks, verandas and the like where they exceed 1.5 m in depth.

511.8 Exterior docks and platforms

Sprinklers shall be installed under the floor of exterior docks and loading platforms of combustible construction unless such space is closed off against the accumulation of debris.

511.9 Enclosed paint lines, drying ovens and drying enclosures

Sprinkler protection shall be provided inside the above structures and ducts in which combustible materials can accumulate unless a SSC considers that no benefit would accrue. Sidewall sprinklers may be used for this purpose.

511.10 Extractor hoods and ducts

511.10.1

Extractor hoods over deep friers, or other processes which produce flammable vapours or mists, require sprinklers under the hood. These shall be located in the flow path of the extractant in sufficient numbers to cover the area beneath the hood. Where filter banks are provided, the sprinklers shall be located below the filters. Sidewall sprinklers shall not be used.

The provisions of this clause may be met by the provision of a listed kitchen fire suppression system, complying with UL 300. Such systems will only be acceptable for listing if they include the continuous discharge of water spray or water mist spray, to ensure that any fire does not re-ignite following the discharge of any wet chemical fire suppressant agent.

511.10.2

Ducts where any cross section dimension is 300 mm or greater and which are handling extractants that can lead to build up in the duct of combustible material (including condensed flammable vapours and trapped fly) shall be fitted with sufficient sprinklers inside the duct to wet all interior surfaces and any electric motors therein. Permanent provision shall be made in the duct to allow replacement of such sprinklers.

Exhaust ducts shall have one sprinkler located at the top of any vertical riser and at the mid-point of any offset. The first sprinkler in a horizontal duct shall be installed at the duct entrance. Horizontal ducts shall have sprinklers located at 3 m centres, with the first sprinkler located no more than 1.5 m from the duct entrance. See figure 5.6.

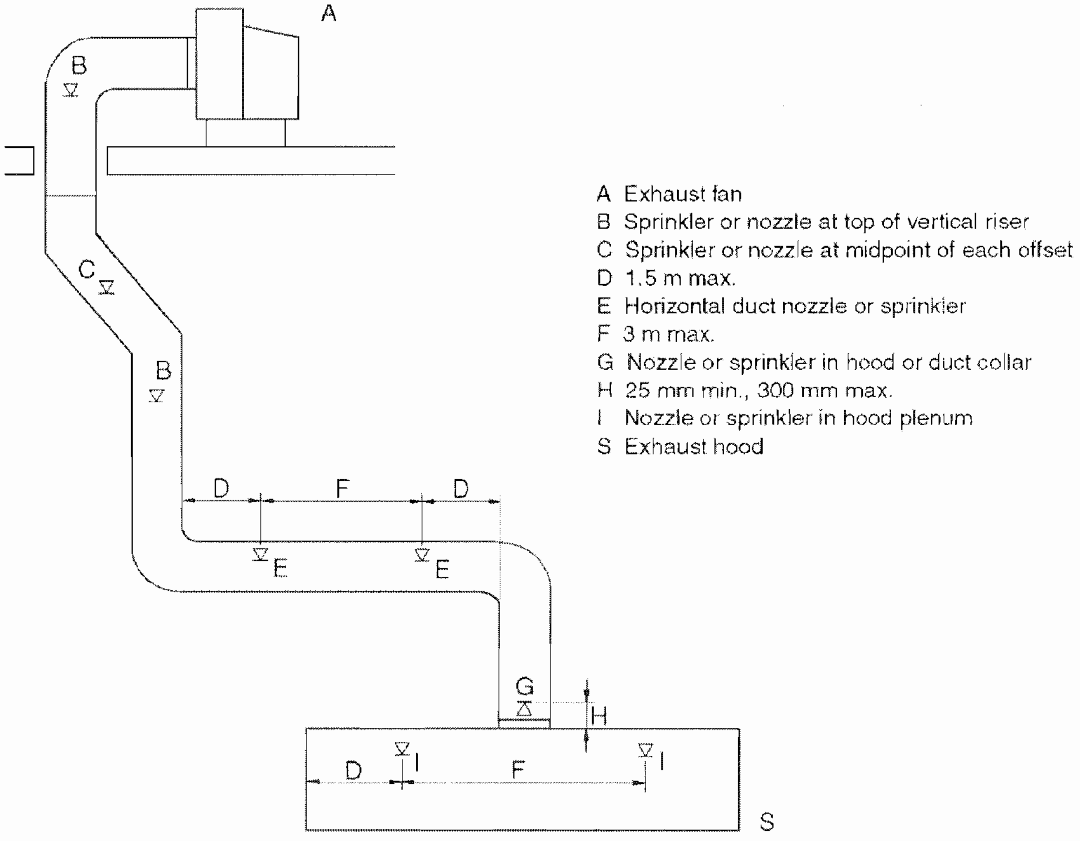

A
B
C
B
D
F
D
E
E
G
H
D
I
F
I
S
A Exhaust fan
B Sprinkler or nozzle at top of vertical riser
C Sprinkler or nozzle at midpoint of each offset
D 1.5 m max.
E Horizontal duct nozzle or sprinkler
F 3 m max.
G Nozzle or sprinkler in hood or duct collar
H 25 mm min., 300 mm max.
I Nozzle or sprinkler in hood plenum
S Exhaust hood

Figure 5.6 – Location of sprinklers in extraction ducts

In the case of commercial cooking hoods, a sprinkler shall be located between 25 mm to 300 mm above the point of the duct collar connection into the hood plenum. Hood exhaust plenums shall have one sprinkler in each chamber not exceeding 3 m in length.

Where a kitchen extraction hood is protected by a listed system as allowed by 511.10.1, and such a system is listed for the protection of ductwork, additional sprinkler protection is not required to be provided for sections of ductwork which provide extraction for a single kitchen hood only.

NOTE –
(1) Attention is drawn to 402.4.2 concerning temperature rating of sprinklers.
(2) Sprinklers may require routine cleaning.
(3) Experience has shown that fires in friers are effectively controlled by sprinklers without consequential risk of injury.

511.10.3

Bench type recirculating fume cupboards of less than 2 m^3 volume are not required to be sprinkler protected.

Bench type recirculating fume cupboards greater than 2 m^3 volume require sprinkler protection, unless a specific adverse reaction of the proposed contents with water is proven to the satisfaction of a SSC.

Bench type or walk-in vented fume cupboards require sprinkler protection regardless of volume. Where combustible ducting material is used, one sprinkler additional head is to be located between 25 to 300 mm above the point of duct collar connection into the cupboard plenum area.

NOTE – Automatic fire sprinkler operation without either a fire or mechanical interference is extremely unlikely. The likely effects of a fire in an unprotected fume cupboard containing combustible solvents and chemical reagents, combined with potential fire spread to concealed spaces and other areas through duct work, is considered a significantly greater hazard to life safety and property protection than a fire in a fume cupboard controlled by sprinkler discharge. It should also be noted that the hazards associated with water and/or other incompatible reagents are often already in the fume cupboards. Manual firefighting is seldom effective as automatic sprinkler protection, and fume cupboards can be unattended. The proximity of a firefigher to the fire, the effects of extinguisher discharge and any subsequent chemical reactions with the extinguishing agent are also considered to pose a greater life safety hazard than automatic fire sprinkler discharge.

Suitable anti-corrosion measures are required in respect of all sprinkler hardware installed in fume cupboards or associated ducting.

NOTE – The known adverse water reactions of high replacement series metals (potassium, lithium, sodium, barium, calcium and magnesium) together with complex metal hydrides, metal carbides, metal phosphides and metal nitrides should be duly noted.

511.11 Electrical substations

Where medium to high voltage (over 400 V) switchgear and associated equipment, or high wattage equipment, are within a sprinkler protected building, the rooms containing such items shall be sprinkler protected. Hoods or shields may be installed to protect vulnerable electrical equipment from direct sprinkler discharge subject to SSC agreement. Where oil-filled equipment is used consideration must be given to the use of waterspray systems. See 203.5.2.

Sprinklers may be omitted from these rooms if the room containing this equipment is an enclosure of FRR 120/120/120 including protection of any penetrations and access openings. Fire doors shall have a FRR of –/120/60.

NOTE – If a room containing oil-filled electrical equipment is not protected it is recommended that the room be of masonry construction with suitable provisions for bunding and explosion venting, in accordance with Clause F3 of the New Zealand Building Code. The effectiveness of sprinkler protection in controlling fires in such risks is well proven.

511.12 Other situations

In any other situation where the meaning of ‘throughout’ in 204 is uncertain, the need for additional sprinklers shall be determined by having regard to whether the heat will reach the sprinklers sufficiently early and whether the discharge from other sprinklers will satisfactorily control the source of heat.

512 OBSTRUCTIONS BELOW SPRINKLERS

512.1 General

Where obstructions below sprinklers are such that the operation of sprinklers could be delayed, or effective distribution of water from the sprinklers could be impaired, sprinklers shall be mounted below such obstructions in accordance with the following requirements.

512.2 Suspended or floor mounted vertical obstructions

512.2.1

In light hazard occupancies only, the distance of all spray sprinklers (standard and extended coverage, vertical and sidewall) to privacy curtains, freestanding partitions, room dividers and other similar obstructions shall comply with table 5.5 and figure 5.7.

512.2.2

For ordinary and extra high hazard occupancies these types of obstruction shall be treated as a wall unless the vertical clearance of the sprinkler obstruction is more than 500 mm for OH and 900 mm for EHH.

Table 5.5 – Extended coverage and extra light hazard spray sprinkler distances from suspended or floor mounted obstructions (see figure 5.7)

Horizontal distance from sprinkler to far side of obstruction Dimension (a) in mm	**Minimum height of sprinkler deflector above top of obstruction** Dimension (b) in mm
Less than 150	75
150 to less than 225	100
225 to less than 300	150
300 to less than 375	200
375 to less than 450	240
450 to less than 600	320
600 to less than 750	400
750 and greater	500

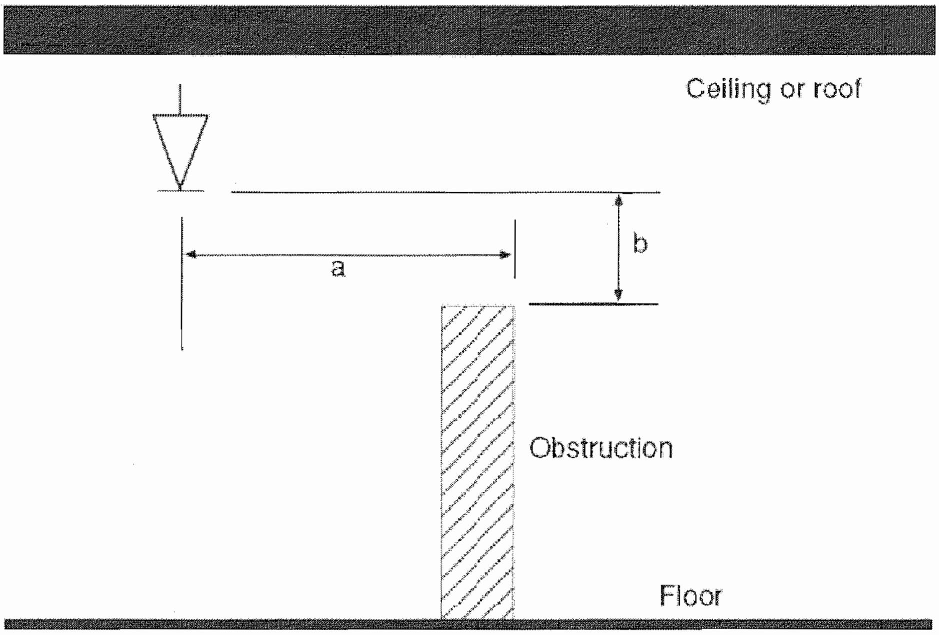


Figure 5.7 – Position of sprinkler head to avoid suspended or floor mounted obstruction to sprinkler discharge (extended coverage or extra light hazard spray sprinklers)

512.3 Overhead platforms and perforated ceilings and decks

512.3.1

Sprinklers shall be installed below internal overhead platforms, heating panels, galleries, walkways, stagings, stairs and stairways and chutes exceeding 800 mm wide and closer than 150 mm to adjacent walls. If the clearance from adjacent walls exceeds 150 mm, sprinklers shall be fitted below any such structure which exceeds 1000 mm width.

512.3.2 *Perforated ceilings and decks*

Sprinklers shall be provided below perforated ceilings and decks according to the proportion of open areas as set out below. In determining compliance the openings or perforations comprising an "open area" shall have no dimension less than 6.5 mm, the depth of the ceiling or deck shall be no greater than any dimension of the openings, and its top plane shall be at least 1000 mm below the deflectors of the sprinklers above.

Proportion of open area %	**Protection required**
0 – 25	Sprinklers beneath
26 – 50	Sprinklers beneath and a solid cover above each sprinkler at least 1 m^2 in area
51 – 70	Sprinklers beneath and a solid cover over the whole of the deck or ceiling
>71	Sprinklers not required

512.4 Ducts

Sprinklers shall be installed under rectangular ducts exceeding 800 mm width and under circular ducts exceeding 1000 mm diameter unless there is at least 150 mm clearance from adjacent walls in which case the width and diameter without protection may be 1000 mm and 1200 mm respectively. Where a duct is erected with the top of the duct less than 500 mm (or in extra high hazard 1000 mm) below the sprinkler deflector, it shall be regarded as a beam and the requirements of 506 shall apply.

512.5 Suspended ceilings

Sprinklers shall be installed below suspended ceilings (as, for example, in connection with diffused lighting) except where the ceiling construction has been shown to the satisfaction of a SSC not to impair detection and the effective water distribution from the sprinklers above.

512.6 Hoods over papermaking machines

The underside of hoods or shields over the dry ends of papermaking machines shall be sprinkler protected. Sidewall sprinklers may be used for this purpose.

512.7 Work tables

Sprinkler protection shall be provided under any work table where the width exceeds 2.0 m or the length exceeds 10 m or both, if the table is of combustible construction or the area beneath is open sided so as to permit the accumulation or storage of combustibles or rubbish.

Sprinklers may be omitted if the area beneath the table is subdivided, by vertical partitions having a –/30/30 FRR, at intervals not exceeding 5 m in either direction and that table is not used for storage of combustibles classified higher than Category 1.

512.8 Sliding filing systems

Where the total area occupied by the filing systems exceeds 4 m^2 the sprinkler head layout shall provide at least one head within 1000 mm of the centre line of sliding filing systems (for example of Lundia type).

Where the clear space above these cabinets is less than 300 mm, the sprinkler head layout should be arranged so that sprinklers are located immediately above the cabinets.

513 FILM AND TELEVISION PRODUCTION STUDIOS

513.1

Overhead platforms or walkways including those for lighting or other equipment, whether slatted or not together with stairs thereto, shall be fitted with sprinklers on the underside if they exceed 800 mm width. (This does not apply to temporary platforms in connection with sets.)

513.2

Concealed spaces or cavities between walls and combustible linings which exceed 100 mm width and those between roofs and combustible linings which exceed 100 mm depth, shall be fitted with sprinklers. Electric cables are permitted provided the wiring is either in screwed steel conduit or in mineral-insulated metal-sheathed cable.

514 THEATRES AND MUSIC HALLS

514.1 Proscenium openings

Where drenchers are installed on a proscenium opening and the water supply for the drenchers is common to any water supply to the sprinkler system, the system of drenchers shall be deemed a part of the sprinkler system and the following requirements shall apply.

NOTE – For the purposes of determining the water supply requirements for the sprinkler system in terms of 602, the maximum flow and pressure requirements for the drenchers should be added to those required in Parts 7, 8 and 9 and any addition required by 206 in the case of external sprinklers.

All design and constructional details of the drencher system shall comply with the relevant provisions of this Standard.

The flow requirement of the drenchers in the case of a system incorporating open-head drenchers shall be established by the sum of $Q = K\sqrt{P}$ for all drencher heads, where K is the K-factor of the head and P is the highest pressure at which each head will operate when the least favourable design area of the sprinkler system is in operation.

NOTE – This clause should not be taken to impose any requirement or preference for the provision of drenchers on a proscenium opening in a sprinklered building.

515 CUPBOARDS AND WARDROBES

515.1

All in-built enclosures such as understair cupboards and floor-to-ceiling height cupboards or wardrobes shall be protected. The permitted exceptions noted in 515.2 shall not be applied to any enclosure that contains electrical switchboards or circuit breaker panels, or other potential sources of ignition, such as water heaters, clothes washers and driers and the like, or if the enclosure is located in a sleeping area.

515.2

Cleaners' cupboards, kitchen pantries and linen cupboards being less than 2 m^3 in volume are not required to be sprinklered subject to the following:

(a) If the enclosure is open to the void space over, the void space is sprinkler protected; or

(b) If the enclosure has a ceiling and the ceiling is constructed of a flame barrier complying with the Compliance Documents of the New Zealand Building Code, and the enclosure is provided with a vent into the sprinklered area by a clear opening of at least 0.02 m^2 free area in the top of the enclosure.

NOTE – 10 mm gypsum plasterboard meets this requirement.

516 SKYLIGHT SHAFTS

Skylight shafts shall be protected except where:

(a) The skylight projects through a sprinkler protected concealed space and is less than 1000 mm deep with a cross-sectional area of less than 1 m^2; or

(b) The volume of the skylight shaft is less than 1.5 m^3 and its partitions have a 10 minute flame barrier as defined in the Compliance Documents of the New Zealand Building Code.

517 EXTERNAL SPRINKLERS

517.1 Extent of application

Any part of an external wall of the sprinkler-protected building, including glazed openings and roof overhangs with a FRR less than –/30/30 required to be protected from an Exposure Hazard, shall be protected with external sprinklers.

For the purpose of this clause 'external wall' shall include the façade of raised sections of the building, such as roof lanterns, set back from the perimeter of the sprinkler-protected building; and 'Exposure Hazard' shall mean a source of radiant heat such as a nonsprinkler-protected building with a FRR less than –/30/30 or areas used for storage or handling of flammable or combustible materials.

517.2 Sprinklers

All sealed sprinklers used for exposure protection shall be rated as quick response and shall have a temperature rating of 93 °C.

Sprinklers shall be any of the following types and orientation:

(a) Pendent Spray (SP) – mounted horizontally with the deflector towards the window or wall;

(b) Upright Spray (SU) – mounted horizontally with the deflector away from the window or wall;

(c) Pendent Sidewall (WP) – mounted pendent and oriented to direct the spray towards the window or wall; or

(d) Sprinklers specifically designed for the purpose and located and spaced in accordance with their listing.

Conventional sprinklers (CU/P) shall not be used, except in the case of protection beneath roof overhangs. Sprinklers beneath roof overhangs shall not be considered a substitute for protection of walls.

517.3 Shielding

Where building features do not shield sprinklers to prevent cooling from sprinklers operating above, such sprinklers shall be fitted with metal shields not less than 80 mm diameter for pendent/upright sprinklers, or 150 mm x 100 mm for horizontal sprinklers.

517.4 Sprinkler spacing and location

Unless specifically listed otherwise, sprinklers shall be located in accordance with table 5.6.

In addition to the requirements contained in table 5.6, a sprinkler shall be positioned not more than 1.25 m horizontally from:

(a) The vertical extremities of the protected surface;

(b) The vertical extremities of each glazed opening, with the sprinkler located within the opening; and

(c) The centre of any building feature such as downpipes and glazing bars or mullions, which project more than 40 mm from the protected surface.

Where vertical glazing bars or mullions project more than 40 mm from the glazed surface and are spaced not more than 1,660 mm centre to centre, every alternate sprinkler may be positioned on the centre line of a mullion or glazing bar, except that sprinklers shall be positioned within 1.25 m of each side of any vertical glazing bar or mullion that exceeds 40 mm in width.

A1

Table 5.6 – Sprinkler spacing and location

Distance	Position	Maximum	Minimum	Point of measurement
Distance between sprinklers	Horizontally	2.5 m	1.8 m (see Note)	Centre of sprinkler
	Vertically	4.0 m	N/A	Deflector to deflector
Horizontal distance from wall	Horizontal sprinkler	100 mm	50 mm	Sprinkler deflector
	Pendent sprinkler	300 mm	100 mm	Centre of sprinkler
Vertical distance below top of protected surface	Horizontal sprinkler	100 mm	50 mm	Centre of sprinkler
	Pendent sprinkler	100 mm	50 mm	Sprinkler deflector
NOTE – The 1.8 m minimum distance may be reduced where sprinklers are separated by a baffle or building feature which will prevent cooling from an adjacent operating sprinkler.				

517.5 Performance

Sprinkler systems that incorporate exposure protection shall be fully hydraulically designed so that the flow from any external sprinkler shall be not less than 75 L/min when the required maximum number of external sprinklers are operating.

Where the area to be protected by an individual sprinkler is less than 2.5 m wide, the flow rate may be reduced proportionally subject to a minimum end head pressure of 70 kPa.

The required number of sprinklers assumed to be in simultaneous operation shall be the number of sprinklers opposed to each Exposure Hazard, (see 206.1.1 and 206.1.2). Hydraulic calculation methods shall conform to the requirements of Part 10, as appropriate.

Sprinklers that are specifically listed for this purpose shall comply with the performance criteria given in the listing.

517.6 Water supply

If the maximum calculated demand of the exposure protection is in excess of that required for the internal sprinklers alone, the water supply shall be increased to cover the excess.

518 SPECIAL REQUIREMENTS FOR SUPPRESSION MODE SPRINKLERS

NOTE – In previous editions of this Standard, these sprinklers were known as Early Suppression Fast Response Sprinklers.

518.1 General

Suppression mode sprinklers offers a number of attractive advantages over other technologies in the protection of some risks. The most significant advantage is often the elimination of in-rack sprinklers. Achieving these advantages requires a technology vastly different to previous technology, which has much less tolerance to deficiencies in design and installation when compared to previous technologies. For new facilities, suppression mode sprinkler design requirements must be incorporated into the building design from the earliest stages of planning. Otherwise the use of suppression mode sprinklers may not be possible. In addition, retrofitting suppression mode sprinklers into existing buildings may not be possible.

Further information on the installation requirements for suppression mode sprinklers may be found in the latest edition of FM Global's Data Sheet 2-2. If, as the result of full scale fire testing, or loss history, the requirements of the latest edition of FM 2-2 differ from the requirements of this Standard, a SSC may publish an advisory notice allowing the use of this document as an alternative means of compliance.

518.2 Building construction

518.2.1 *Roof construction*

Except as noted below, install sprinklers in every bay or channel formed by solid structural elements at the roof and ceiling.

Sprinklers are not required in every bay or channel, when the structural elements are less than 300 mm deep, and the sprinkler deflectors are located below the bottom of the members. An example of such construction includes metal-framed buildings, with purlins of less than 300 mm depth.

518.2.2 *Ceiling and roofs*

Do not install suppression mode sprinklers below a roof slope exceeding 10°. Where the slope exceeds 10°, sprinklers may be installed below a subceiling of a slope of less that 10°.

Where the ceiling height is higher than permitted, suppression mode sprinklers may be installed below a subceiling to reduce the height to an acceptable ceiling. Ceiling heights are measured to the underside of the roofing material or cladding. For corrugated roofs, with corrugations less than 76 mm deep, measure to the bottom of the cladding. For deeper corrugations, measure to the top of the cladding.

A1 Design suspended ceilings to withstand fire plume uplift pressures of at least 140 Pa.

518.2.3 *Ventilation and venting*

518.2.3.1 *Heat and smoke venting*

Automatic heat and smoke vents in area protected with suppression mode sprinklers shall use a high temperature (i.e. with an operating temperature in excess of 141°C) operating mechanism.

Do not install suppression mode sprinklers in areas with melt-out (drop-out) type vents. Plastic skylights that are not designed as heat/smoke vents do not create this problem.

518.2.3.2 *Roof and ceiling-level ventilation*

Natural and powered ventilation can lead to critical delays in suppression mode sprinkler operation. Examples of powered ventilation include exhaust fans, air conditioning/refrigeration supply and return vents and air inlets to roof mounted mechanical equipment. Examples of natural ventilation include turbine vents, vent stacks and ridge vents.

It is necessary to coordinate the location of suppression mode sprinklers and ventilation to ensure that the air velocity at sprinklers does not exceed 1.5 m/s. If this is not possible, one of the following design options may be applicable:

(a) If the vent openings have a maximum dimension of less than 1.4 m, centre a suppression mode sprinkler in the opening. This option does not apply to commodities greater in hazard than cartoned unexpanded plastics, such as uncartoned plastics, aerosols, or rolled tissue in buildings higher than 9.1 m.

(b) Install a subceiling under the vent and install suppression mode sprinklers under the ceiling. The subceiling shall be designed to limit the air velocity at the sprinklers to under 1.5 m/s.

(c) Install linear type heat detection or flame detection to shut down the fans in powered ventilation, or close dampers in natural ventilation. The latest edition of FM Data Sheet 2-2 provides design guidance on this option.

The only practical way to protect ridge type vents is by providing sprinklers beneath them at roof level for vents no wider than 1.4 m, or by installing a subceiling with suppression mode sprinklers beneath them, as described in (b) above.

518.2.3.3 *Draft curtains*

Draft curtains may be required to separate between areas protected by suppression mode sprinklers and other types of sprinklers, to ensure that the suppression mode sprinklers do not operate, and divert excessive amounts of water away from the fire. They shall be centred between rows of sprinklers.

When required, they shall extend at least 600 mm below the ceiling, be of noncombustible construction, and fit tight under the ceiling. Openings created by ribs in roofing material are not a concern, but channels created by gaps between purlins and roofing material need to be filled. Solid beams or other structural features can meet the requirement for draft curtains.

Draft curtains shall be centred over clear aisles at least 1.2 m wide (see 902.9).

518.3 Sprinkler installation criteria

518.3.1 *Spacing*

518.3.1.1 *General requirements*

For buildings up to 9.1 m height, install sprinklers at a maximum spacing of 3.7 m apart.

For buildings greater than 9.1 m height (but less than 13.7 m high) the maximum spacing between sprinklers is 3.1 m.

The minimum spacing between sprinklers is 2.4 m.

518.3.1.2 *Special circumstances*

Elimination of obstructions is critical to the success of suppression mode sprinkler operation (see 518.4). In some cases, where a slight extension of the spacing requirements provided in 518.3.1.1 in isolated areas can eliminate obstructions. If increasing spacing between two adjacent heads on a range or between two adjacent ranges can eliminate obstructions, then the following extensions are allowable:

(a) In buildings up to 9.1 m high, the maximum spacing of 3.7 m may be increased to 4 m and the area of coverage may be increased to 10.2 m^2 for those sprinklers that need to be moved in order to be at least 300 mm from obstructions;

(b) In buildings over 9.1 m and up to 12.2 m high, the maximum spacing of 3.1 m (see 518.3.1.1) may be increased to 3.4 m, with a maximum area of coverage of 10.2 m^2, for those sprinklers that need to be moved in order to be at least 300 mm from obstructions.

These extensions apply only to a maximum of two adjacent sprinklers on a range or two adjacent ranges. See figure 5.8.

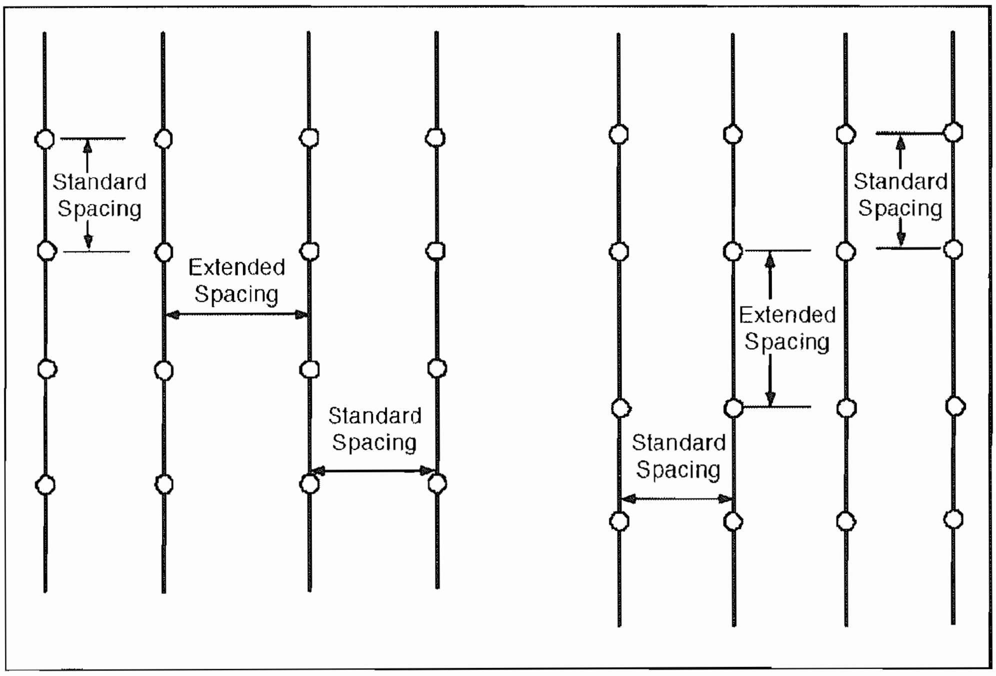


Figure 5.8 – Examples of allowable extended spacings for suppression mode sprinklers to avoid obstructions

518.3.2 *Area per sprinkler*

Install suppression mode sprinklers at a maximum area per sprinkler of 9.3 m^2, except as allowed by 518.3.1.2.

Install suppression mode sprinklers at a minimum area per sprinkler of 6.0 m^2.

518.3.3 *Distance below ceiling*

Suppression mode sprinklers shall be installed with either the centre line of their thermal sensing elements, or their deflector distances below the ceiling in accordance with table 5.7.

Table 5.7 – Suppression mode sprinklers – Allowable distances below ceiling

Type of sprinkler	Distance of deflector below ceiling (mm)		Distance of centre line of thermal sensing element below ceiling (mm)	
	Minimum	**Maximum**	**Minimum**	**Maximum**
*K*20 or *K*24 Pendent	127	356	102	330
*K*20 or *K*24 Upright	N/A	N/A	102	330
*K*32 or *K*36 Pendent	152	457	102(*)	457(*)

* The ability to install *K*32 and *K*36 heads with a thermal sensing element at 457 mm below the ceiling is based on FM Global's design criteria. The use of this criterion is only acceptable if FM design criteria are used.

518.3.4 *Clearance to storage*

Ensure that at least 900 mm clearance is maintained between storage and suppression mode Sprinkler Deflectors.

518.4 Obstructions to suppression mode sprinkler discharge

518.4.1 *General*

Effective operation of suppression mode sprinklers requires that water be delivered directly to burning commodities at high volume and high momentum. Obstructions can interfere with the distribution pattern and significantly reduce downward momentum of the water discharge and penetration of the fire plume, resulting in a failure to suppress a fire. In the types of storage protected by suppression mode sprinklers, this will result in an uncontrolled fire.

Testing has clearly shown that even comparatively small obstructions, when they are at critical locations, can result in an uncontrolled fire if the fire starts beneath them.

Obstructions can be located at or near the ceiling, or entirely below sprinklers. These include, but are not limited to: beams, girders, truss and bar joist bottom chords, wind bracing and bridging, ducts, heaters, cable trays, conduit, sprinkler system or other piping, noise abatement curtains, draft curtains, lighting fixtures, etc.

518.4.2 *Solid obstructions at ceiling level*

518.4.2.1 *General*

Obstructions extending from a point at or above the level of a sprinkler to a point below the sprinkler deflector can block a significant portion of the sprinkler discharge. Typical examples of this type of obstruction include, but are not limited to: concrete or steel beams, steel girders, joists or trusses whose webs are less than 70 % open, draft curtains, etc. The only way to mitigate this effect is to locate sprinklers in relation to the obstructions such that the "umbrella" of the discharge pattern passes beneath the obstruction.

To accomplish this, locate sprinklers so that the vertical distance from the sprinkler deflector to the bottom of the obstruction and the horizontal distance from the nearest edge of the obstruction are as shown in figure 5.9.

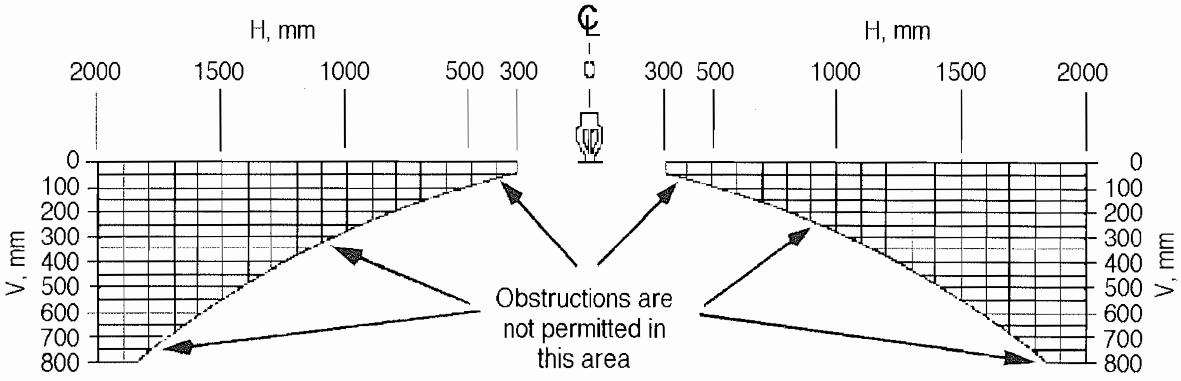
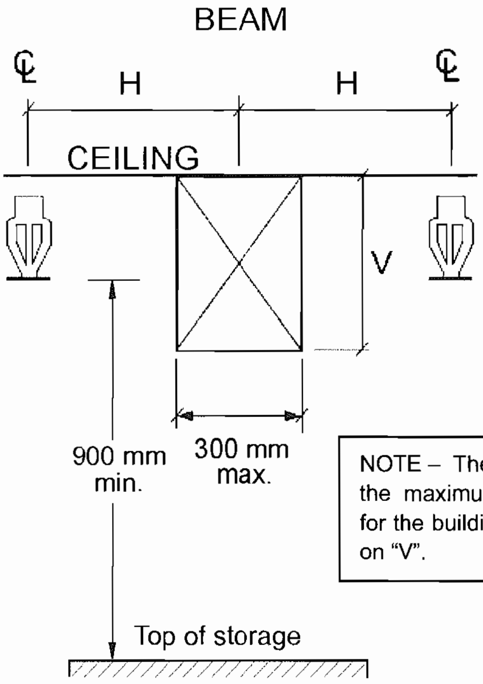


Figure 5.9 – Area where obstructions not allowed

As an alternative for beams, girders, draft curtains and other obstructions at ceiling level that are no more than 300 mm wide, locate sprinklers on either side of the obstruction no more than 1.8 m from the nearest edge of the obstruction in buildings up to 9.1 m high, and no more than 1.5 m from the nearest edge of the obstruction in buildings up to 13.7 m high. Maintain a minimum of 900 mm clearance between the top of storage and the obstruction above it (see figure 5.10). Meeting the requirements of this section will mitigate obstructions created by other objects, although it may not be the most practical solution. Alternate requirements for specific types of obstructions are shown in figures 5.10 to 5.17.



NOTE – The maximum permitted "H" is ½ the maximum sprinkler spacing permitted for the building height and is not dependent on "V".

Figure 5.10 – Alternative arrangement for obstructions no more than 300 mm wide at ceilings

518.4.2.2 *Open-web structural members at ceiling-level*

Webs of structural members that are more than 70 % open (referred to as open-web structural members) do not obstruct the sprinkler discharge pattern significantly but the bottom chords of these members can. Bracing and bridging can also significantly interfere with the sprinkler discharge. Provided that any individual sprinkler is only subject to a single obstruction, sprinklers can be located a minimum of 300 mm horizontally from the bottom chord of a bar joist, truss, or a similar open-web structural member, and from bridging (see figure 5.11). Where the horizontal distance between adjacent open-web structural members is less than 900 mm measured between the edges of the bottom chord, a solid barrier or suspended ceiling should be installed beneath the members with sprinklers located beneath.

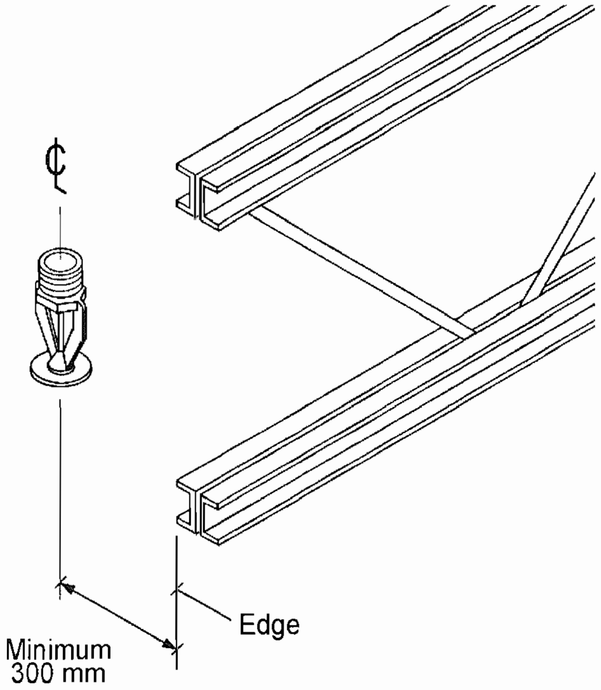


Figure 5.11 – Minimum clearances to bar joists

518.4.3 *Obstructions below sprinklers*

Obstructions located entirely below sprinklers, while they may not create as large an interruption of the distribution pattern of sprinklers, can create "shadows" and reduce the momentum of the sprinkler discharge to the point that a fire will neither be suppressed nor controlled. Testing has shown that a single obstructed sprinkler can result in an uncontrolled fire if it is in a critical location and a fire starts beneath it. An individual obstruction 20 mm wide or less and at least 100 mm below the sprinkler deflector may be ignored.

NOTE – Individual objects and obstructions are considered "individual" only if they are separated from the nearest adjacent object or obstruction by a distance of at least six times their least dimension. For example, a group of six 25 mm diameter conduit spaced 25 mm apart would be treated as a group and would create an obstruction 280 mm wide. If the same group of conduit were spaced 150 mm apart, it would be treated as six 25 mm wide objects.

Obstructions located more than 900 mm below suppression mode sprinklers will not disrupt the discharge pattern, but cannot be ignored because they can obstruct water penetration into flues in storage. Obstructions that are located directly over flues must be at least 900 mm above the flue.

518.4.3.1 *Pendent suppression mode sprinklers*

Obstructions below sprinklers that meet the requirements of figure 5.9 are acceptable. Otherwise, the following requirements shall be met:

(a) For continuous obstructions below sprinklers wider than 20 mm and up to 50 mm wide locate the sprinkler deflector at least 300 mm horizontally from the nearest edge of the obstruction or locate the obstruction at least 600 mm below the deflector (see figure 5.12);

(b) For continuous obstructions greater than 50 mm and up to 300 mm wide locate the sprinkler deflector at least 300 mm horizontally from the nearest edge of the obstruction (see figure 5.13);

(c) For continuous obstructions greater than 300 mm and up to 600 mm wide locate the sprinkler deflector at least 600 mm horizontally from the nearest edge of the obstruction (see figure 5.14);

(d) For obstructions greater than 600 mm wide, meet the criteria in figure 5.9, or:

  (i) If the obstruction is continuous, flat, horizontal and solid, install a line of sprinklers with the thermal sensing elements located a maximum of 330 mm below the centre of the obstruction. Use the same type of sprinkler as used at the ceiling spaced them a maximum of 2.4 m apart. Maintain at least 900 mm between the sprinkler deflector and the top of the storage (see figure 5.15). Include the sprinklers below the obstruction in the 12 head design area operating, and the equivalent number of heads at the ceiling or roof immediately above the obstruction turned off

  (ii) If the obstruction is continuous and not flat (as in the case of a circular duct) or is not solid (as in the case of grouped cables), install a flat barrier under the obstruction at least as wide as the obstruction. Install a line of sprinklers below the centreline of the barrier as described in paragraph (i) (see figure 5.16). Include the sprinklers below the obstruction in the 12 head design area operating, and the equivalent number of heads at the ceiling or roof immediately above the obstruction turned off;

(e) If the obstruction below sprinklers is not continuous and has a circular or rectangular horizontal cross-section less than 600 mm in diameter of 600 mm across the flats respectively (such as a pendant light), locate the sprinkler deflector at least 300 mm horizontally from the nearest edge of the obstruction (see figure 5.17).

518.4.3.2 *Upright suppression mode sprinklers*

Full-scale fire testing done in conjunction with the approval of the *K*20 L/min.kPa$^{-0.5}$ upright suppression mode sprinkler showed small obstructions located directly below the sprinklers have less impact on the performance of the tested sprinkler than on pendent suppression mode sprinklers. Therefore, the obstruction requirements of this Standard can be relaxed as follows:

When upright suppression mode sprinklers are used obstructions below sprinklers can be ignored if any of the following apply:

(a) They are open-web bar joists or trusses having chords no more than 100 mm wide;

(b) They are bridging or wind bracing no more than 100 mm wide; or

(c) They are individual pipes and conduit 100 mm in diameter or less, or individual groups of smaller pipe or conduit having a total width of 100 mm or less.

Where obstructions exceed the limits of (a) to (c) above install suppression mode sprinklers under the obstructions to the same requirements as 518.4.3.1.

NOTE – Individual objects and obstructions are considered “individual” only if they are separated from the nearest adjacent object or obstruction by a distance of at least six times their least dimension. For example, a group of six 25 mm diameter conduit spaced 25 mm apart would be treated as a group and would create an obstruction 280 mm wide. If the same group of conduit were spaced 150 mm apart, it would be treated as six 25 mm wide objects.

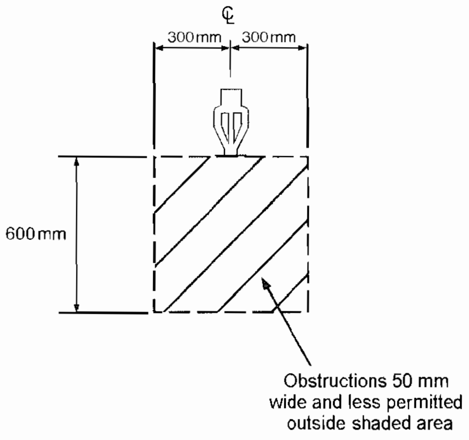
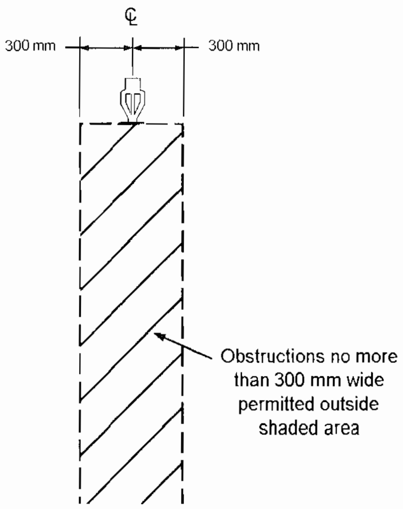

℄
300 mm
300 mm
600 mm
Obstructions 50 mm wide and less permitted outside shaded area

Figure 5.12 – Obstructions greater than 20 mm and up to 50 mm wide below sprinklers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300 mm
300 mm
Obstructions no more than 300 mm wide permitted outside shaded area

Figure 5.13 – Obstructions greater than 50 mm and up to 300 mm wide below sprinklers

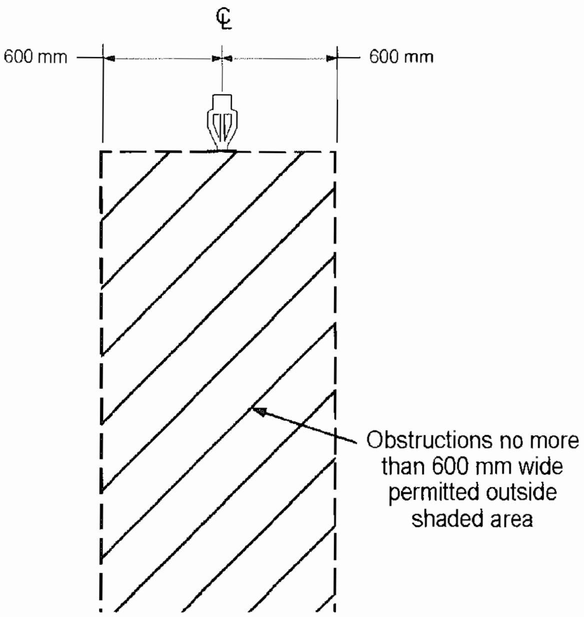

℄
600 mm
600 mm
Obstructions no more than 600 mm wide permitted outside shaded area

Figure 5.14 – Obstructions greater than 300 mm and up to 600 mm wide below sprinklers

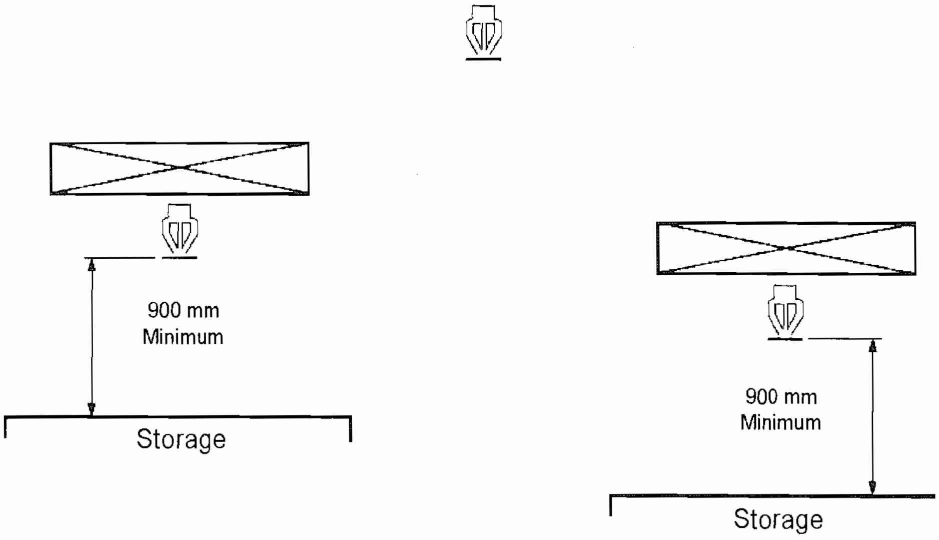


Figure 5.15 – Flat horizontal obstructions greater than 600 mm wide below sprinklers

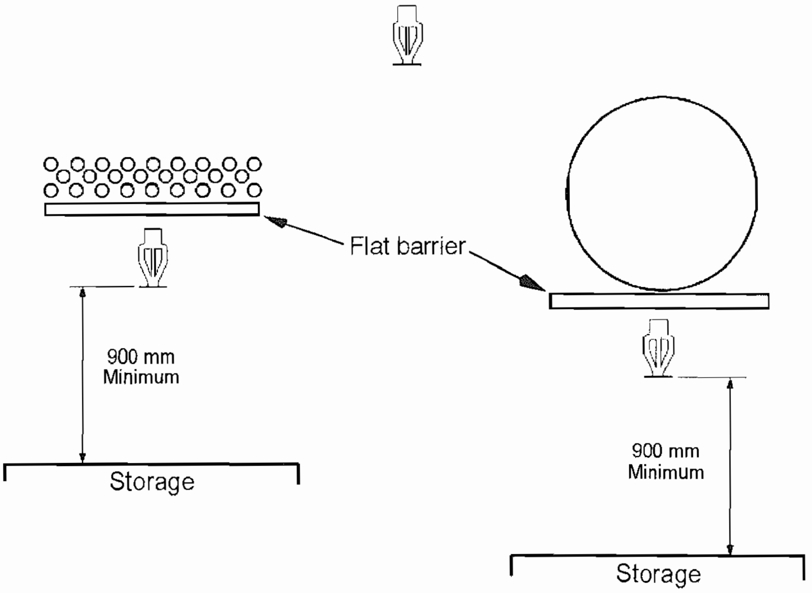
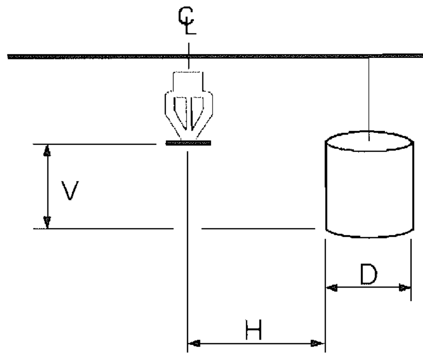


Figure 5.16 – Round or rectangular obstructions less than 600 mm wide below sprinklers



When D is 600 mm or less, H can be 300 mm or greater, independent of V.

Figure 5.17 – Round or rectangular obstructions below sprinklers less than 600 mm wide

518.4.4 *Mezzanines, walkways and conveyors*

Mezzanines, walkways and conveyors installed in warehouses protected by suppression mode sprinklers at the roof can prevent water discharge from sprinklers reaching and suppressing a fire. Additional sprinklers shall be required beneath the obstruction in the following circumstances.

518.4.4.1 *Solid mezzanines*

To prevent simultaneous operation of suppression mode sprinklers beneath and above solid mezzanines and to allow the water demand for sprinklers under the mezzanine to be independent of the water demand or sprinklers above, either provide a draft curtain around the perimeter of the mezzanine or keep all storage underneath the mezzanine inside the sprinklers located nearest the perimeter of the mezzanine.

For mezzanines extending no more than 4.6 m above floor level, install suppression mode sprinklers designed to supply four sprinklers at the pressure required for the type of sprinkler used, or quick response sprinklers designed for the hazard involved.

For solid mezzanines extending more than 4.6 m above floor level, install suppression mode sprinklers using the design criteria required for the storage height and type of sprinkler used.

Control-mode sprinklers designed for the hazard involved may be used below a mezzanine more than 4.6 m high only if a draft curtain is provided at the perimeter.

518.4.4.2 *Grated mezzanines*

In order to be considered grated, the grating of a mezzanine must be least 70 % open. If the grating is less than 70 % open, then make the mezzanine solid (in order to allow sprinklers underneath it to operate promptly) and protect it as a solid mezzanine according to 518.4.4.1.

If storage exists either above or below a grated mezzanine, but not both above and below, no additional sprinklers are needed under the mezzanine.

If storage or storage structures above and below grated mezzanines are arranged to provide aisles that are vertically aligned above and below, treat the aisle portions of the mezzanines the same as walkways. (See 518.4.4.3.)

If storage or storage structures are not vertically aligned above and below the mezzanine, regardless of openings in the grating, make the mezzanine solid and protect it as a solid mezzanine according to 518.4.4.1.

518.4.4.3 *Walkways*

Walkways are located between storage structures for material-handling purposes. In order to be considered grated, the grating of a walkway must be least 70 % open. Treat grated walkways wider than 3.1 m as grated mezzanines.

No additional sprinklers are required under single-level grated walkways that are no more than 3.1 m wide.

For multi-level grated walkways no wider than 3.1 m, provide one line of suppression mode or quick response control-mode sprinklers (K of 11.5 or greater, 68 °C temperature rating). For two-level walkways, install them beneath the lower walkway. For three-level walkways, install them beneath the mid-level walkway.

Locate the sprinklers at the centre of the walkway, at a maximum horizontal spacing of 3 m. Include two of these sprinklers when calculating the ceiling sprinkler water demand. For suppression mode sprinklers, supply these two additional sprinklers at the minimum pressure approved for the type of sprinkler used.

For control-mode sprinklers, design the two sprinklers to discharge a minimum of 230 L/min each.

518.4.4.4 *Conveyors*

Single conveyors are typically located on walkways or mezzanines between storage structures to ease inventory picking. Multiple conveyors are located side-by-side to convey product between storage areas and shipping/receiving areas. In either case, they can obstruct sprinkler discharge and create shielded areas that can prevent fire suppression.

When sprinklers are installed below solid walkways and mezzanines in accordance with this Standard, the addition of conveyors on the mezzanines and walkways does not require additional sprinklers.

For grated mezzanines and walkways with belt-type conveyers (or roller-type conveyers less than 50 % open), individual conveyers or groups of conveyers wider than 600 mm sprinklers in addition to those required for the mezzanines or walkways themselves will be required. The only exception to this requirement is where there is no possibility of combustibles being present beneath the conveyers.

Install suppression mode or quick response spray sprinklers (K of 11.5 or greater, ordinary temperature rating) beneath the conveyers on a maximum horizontal spacing of 3 m. Include two of these sprinklers in the ceiling sprinkler water demand.

For suppression mode sprinklers, supply these two additional sprinklers at the minimum pressure approved for the type of sprinkler used.

For quick response spray sprinklers, design the two sprinklers to discharge a minimum of 240 L/min each. If sprinklers are installed under both the grated mezzanine and walkways and conveyors, it is only necessary to add a total of two sprinklers to the ceiling demand.

When there are multiple, vertically aligned levels of conveyors that are 50 % open or more, add a line of suppression mode sprinklers under the lower conveyor for two levels; add a line under the middle conveyor for three levels.

519 SPECIAL REQUIREMENTS FOR CONTROL MODE SPECIFIC APPLICATION SPRINKLERS

Further information on the installation requirements for control mode specific application sprinklers (CMSA) may be found in the latest edition of FM Global's Data Sheet 2-7.

NOTE – Large droplet sprinklers referred to in previous editions of this Standard are a type of CMSA sprinkler.

519.1 Building construction

When CMSA sprinklers are used under open wood joist construction, the minimum design pressure for the sprinklers shall be 345 kPa.

It is recommended that CMSA sprinklers not be used in conjunction with automatic smoke and heat venting. If automatic vents are used, it is recommended that they be rated to operate at a minimum temperature of 182 °C.

519.2 Sprinkler installation criteria

519.2.1 *Sprinkler spacing*

The maximum spacing for CMSA sprinklers shall be 3.7 m.

When used in conjunction with open wood joist construction, the maximum spacing shall be reduced to 3 m.

The minimum spacing for CMSA sprinklers shall be 2.4 m.

The maximum area of coverage for CMSA sprinklers shall be 9.3 m^2.

The minimum area of coverage shall be 7.4 m^2.

519.2.2 *Range sizes*

Range sizes shall be determined by full hydraulic calculation. Notwithstanding this, the minimum range size shall be 32 mm.

With the exception of the first head on a range, CMSA sprinklers may only be directly connected to 50 mm and smaller pipe. The first head on a range may be directly connected to a 65 mm starter pipe.

Where range pipes exceed 50 mm in diameter, the sprinklers shall be connected to the ranges via riser nipples, to elevate the sprinkler deflectors above the centre line of the pipe as indicated in table 5.8.

Table 5.8 – Required deflector height above range centreline

Range pipe nominal diameter (mm)	**Required height of deflector above pipe centreline** (mm)
50	N/A
65	330
80	380
100	460
>100	N/A

519.2.3 *Clear space below sprinklers*

Maintain a clear space below sprinkler deflectors and the top of storage of at least 900 mm.

519.2.4 *Distance below ceiling*

Ideally, position sprinklers so that the deflector is 90 mm below the bottom of joists in wood joist construction, and 180 mm below the ceiling in other types of construction. Where practical considerations do not allow the ideal distances to be met, comply with the requirements in table 5.9.

Table 5.9 – Minimum and maximum distances of deflectors below ceiling

Construction type	Minimum distance (mm)	Maximum distance (mm)
Smooth ceiling	152	203
Portal and purlin	152	305
Panel up to 28 m^2	152	356
Open wood joist	25 below joist bottom	152 below joist bottom

519.3 Obstructions to CMSA sprinkler discharge

519.3.1 *Ceiling level obstructions*

When CMSA sprinklers are located above the bottom of obstructions such as beams, ducts and the like, they shall be located in accordance with table 5.10, read in conjunction with figure 5.18.

Table 5.10 – Position of deflector when located above bottom of ceiling obstruction

Distance from sprinkler to side of beam or other obstruction (mm)	Maximum distance of deflector above bottom of beam or other obstruction (mm)
Less than 300	0
300 to less than 500	40
500 to less than 600	75
600 to less than 800	140
800 to less than 900	200
900 to less than 1100	250
1100 to less than 1200	300
1200 to less than 1400	380
1400 to less than 1500	460
1500 to less than 1700	560
1700 to less than 1800	660
1800 or more	790

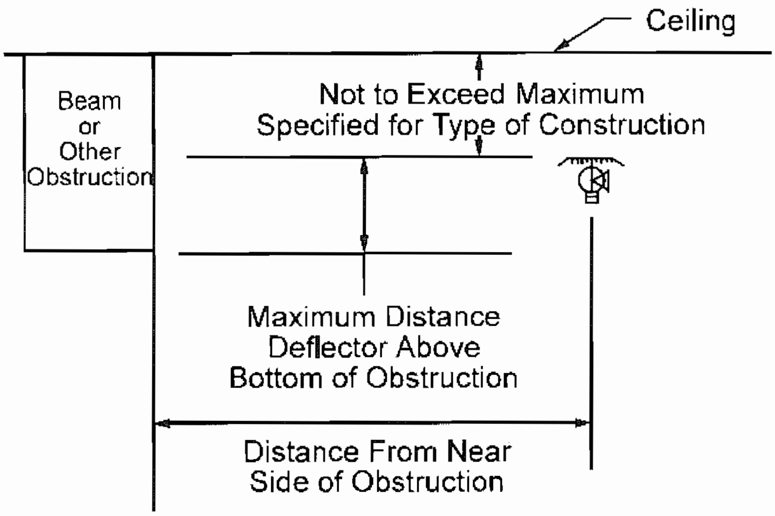

Ceiling
Beam or Other Obstruction
Not to Exceed Maximum Specified for Type of Construction
Maximum Distance Deflector Above Bottom of Obstruction
Distance From Near Side of Obstruction

Figure 5.18 – Position of deflector when located above bottom of ceiling obstruction

519.3.2 *Obstructions located below sprinklers*

Sprinklers shall be located with respect to obstructions located entirely below the sprinkler, such as fluorescent lights, ducts and other obstructions in accordance with table 5.11, and as illustrated in figure 5.19.

Table 5.11 – Position of sprinklers relative to obstructions located entirely below

Distance of deflector above bottom of obstruction (mm)	**Minimum distance to side of obstruction** (mm)
Less than 150	500
150 to less than 300	900
300 to less than 450	1200
450 to less than 600	1500
600 to less than 750	1700
750 to less than 900	1800

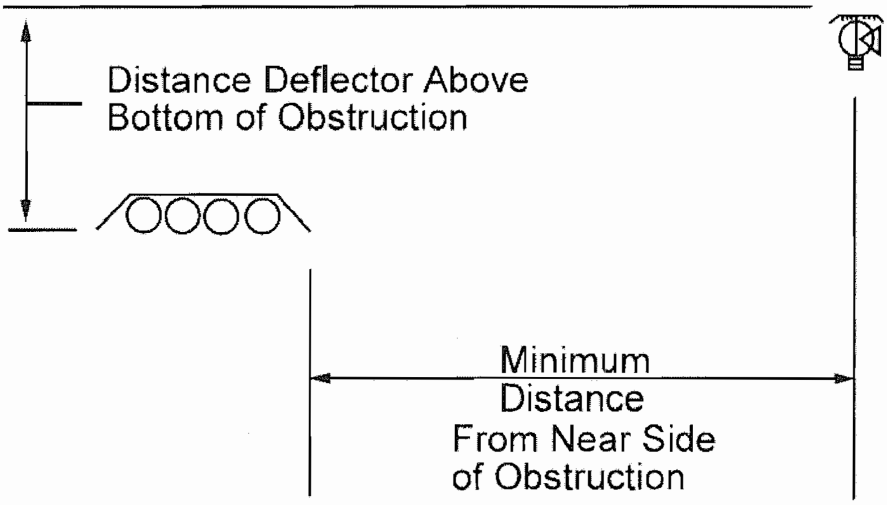

Distance Deflector Above Bottom of Obstruction
Minimum Distance From Near Side of Obstruction

Figure 5.19 – Position of sprinklers relative to obstructions located entirely below

When the bottom of the obstruction is located 900 mm or more below the sprinkler deflectors, position sprinklers so the obstruction is centred between adjacent sprinklers, as shown in figure 5.20. Limit the obstruction to a maximum width of 600 mm. The extension to either side of the mid-point between sprinklers may not exceed 300 mm. Maintain at least a 460 mm clearance between the top of storage and the bottom of the obstruction. Install one or more lines of sprinklers below obstructions with a width greater than 600 mm, or which otherwise do not meet the maximum 300 mm extension requirements of this paragraph.

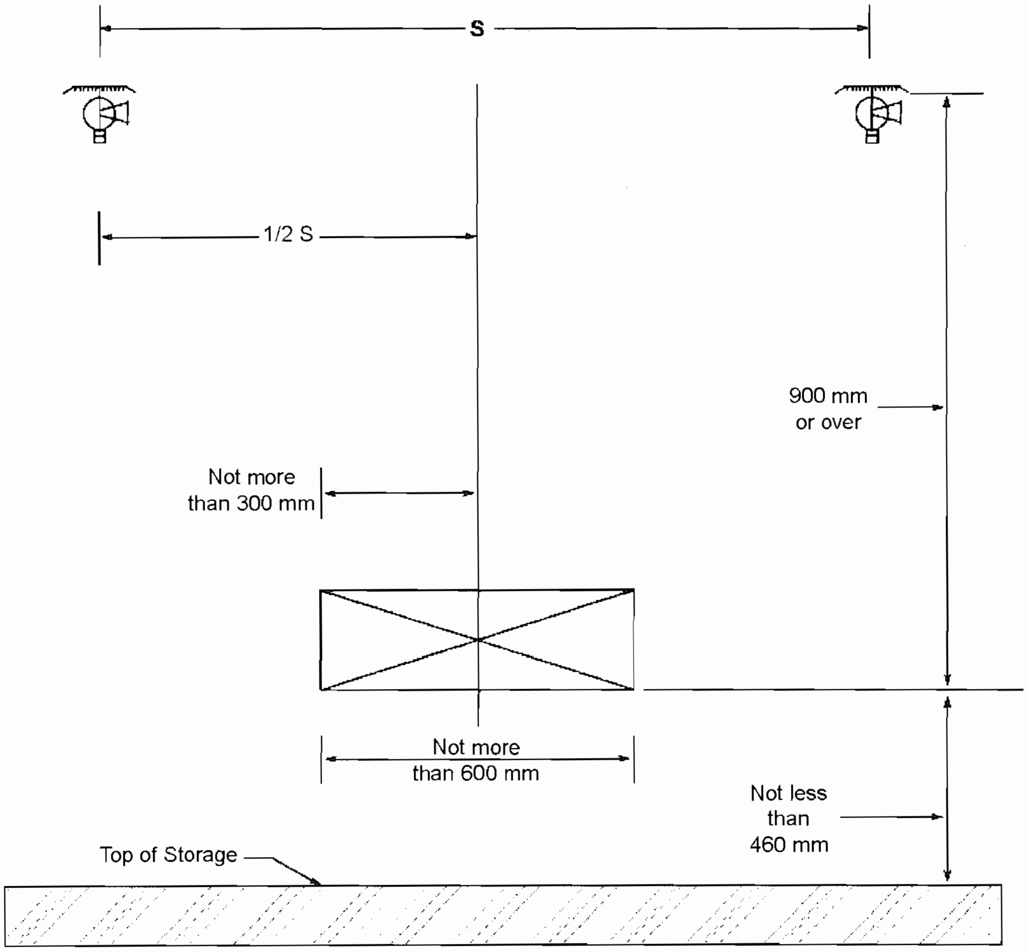


Figure 5.20 – Position of sprinklers in relation to obstructions located 900 mm or more below deflectors

519.3.3 *Obstructions parallel and directly below ranges*

In the special case of an obstruction running parallel to and directly below a range pipe, locate the sprinkler at least 900 mm above the top of the obstruction, as illustrated in figure 5.21. Limit the obstruction to a maximum width of 300 mm and a maximum extension of 150 mm to either side of the centre line of the branch line.

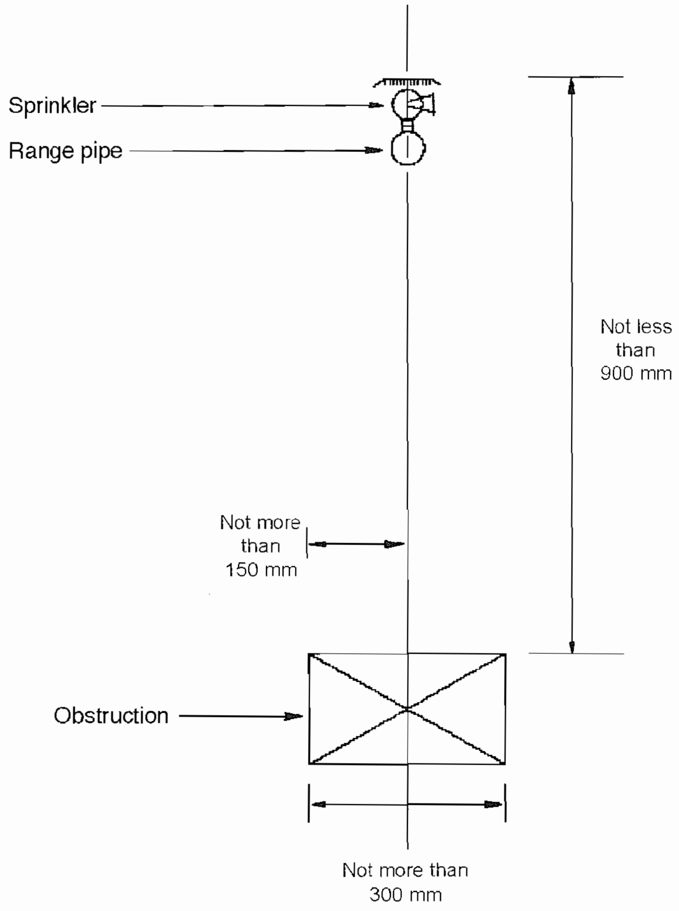


Figure 5.21 – Position of sprinklers in relation to obstructions running parallel to and directly below range pipes

520 EXTENDED COVERAGE ORDINARY HAZARD (ECOH) AND EXTENDED COVERAGE LIGHT HAZARD (ECLH) SPRINKLERS – SPECIAL REQUIREMENTS

520.1 Location

520.1.1

Any specific requirements detailed within the listing for an ECOH and ECLH sprinklers shall be applied in preference to 520.1.2 – 520.1.6.

520.1.2

ECOH sprinklers shall not be installed under ceilings with continuous structural or architectural projections exceeding 150 mm in depth unless the sprinkler is not required to spray beyond such a projection, or specific approval is obtained from a SSC.

520.1.3

The slope of the ceiling shall not exceed 10°. Deflectors shall be installed parallel to ceilings or roofs.

520.1.4

The deflector of the sprinkler shall not be more than 300 mm below the ceiling.

520.1.5

If the deflectors of ECOH and ECLH sprinklers are located at the same level or above ceiling mounted obstructions, then the sprinkler shall be positioned in accordance with the dimensions shown in table 5.12.

520.1.6

Where vertical obstructions exist with a clear space of less than 500 mm above them (e.g. suspended fittings or floor-mounted vertical obstructions, which do not exceed 100 mm in width), the sprinkler shall be positioned in accordance with the dimensions shown in table 5.5.

Table 5.12 – ECOH and ECLH sprinkler distances from ceiling mounted obstructions (see figure 5.22)

Minimum horizontal distance from sprinkler to side of obstruction Dimension (a) in mm	**Maximum height of sprinkler deflector above bottom of obstruction** Dimension (b) in mm
Less than 500	0
500 to less than 900	25
900 to less than 1200	75
1200 to less than 1300	125
1300 to less than 1800	175
1800 to less than 2000	225
2000 to less than 2100	275
2100 or more	350

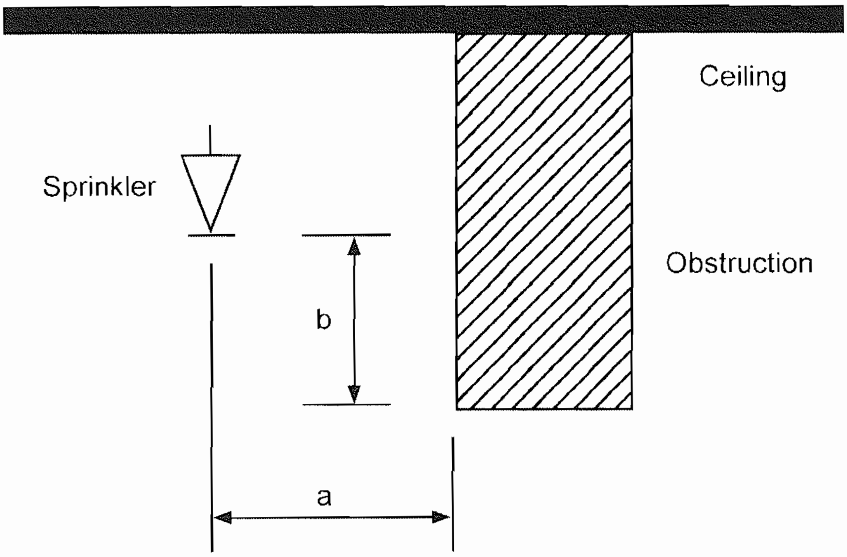


Figure 5.22 – Position of sprinkler head to avoid obstruction to sprinkler discharge (extended coverage upright and pendent spray sprinklers)

Part 6
WATER SUPPLY

601 GENERAL

To ensure its reliability, every sprinkler system shall have a reliable primary water supply complying with this section. An additional or secondary water supply is required by this Standard where the building presents a greater risk to occupants or contents and is larger or higher, thus being more difficult for the Fire Service to control a fire (see 602.5).

A secondary water supply shall not be required for a sprinkler system to comply with the Compliance Documents of the New Zealand Building Code.

602 CLASSES OF WATER SUPPLY

602.1 Classification

The water supply of a sprinkler system shall be classified according to its reliability and number of supplies as follows:

Class A – Dual superior supply

> Two approved supplies, both of which shall be carried independently to a combined main within each control valve enclosure, at least one of which shall be a primary supply, but only one of which may be dependent on a town's main.

Class B2 – Private site fire main

> A private reticulation system which complies with 612 and is reserved solely for fire purposes, being charged with water and normally pressurised, comprising of at least one approved ring and supplied by two approved supplies, at least one of which shall be a primary supply, but only one of which may be dependent on a town's main. The sprinkler system(s) water supply connection pipes shall be independently connected to the fire main. Two connections shall be carried independently to a combined main within each valve enclosure. Isolation valves shall be provided at each connection with the fire main so as to ensure that there are at least two isolation valves between any two connections.

Class C2 – Single superior supply

> A single approved primary supply. Where the supply is reliant on the use of fire pumps, two pumps shall be provided in parallel. Each pump shall be individually capable of meeting the highest design flow and pressure. At least one pump shall be driven by a diesel engine.

Class C1– Single supply

> One approved primary supply.

NOTE – See figure 6.1.

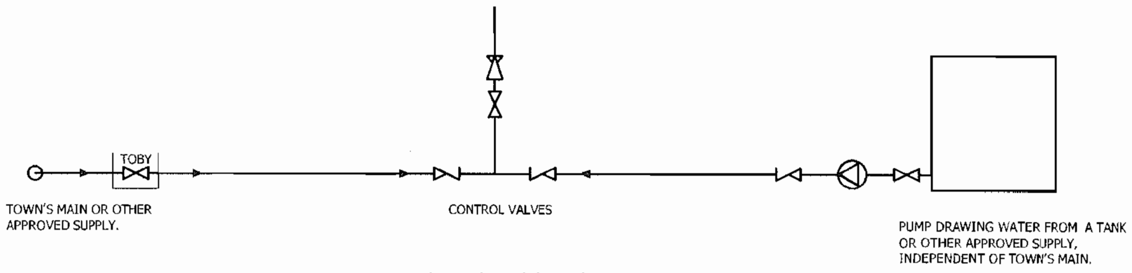
602.2 Primary supply

A primary supply shall be only one of the following:

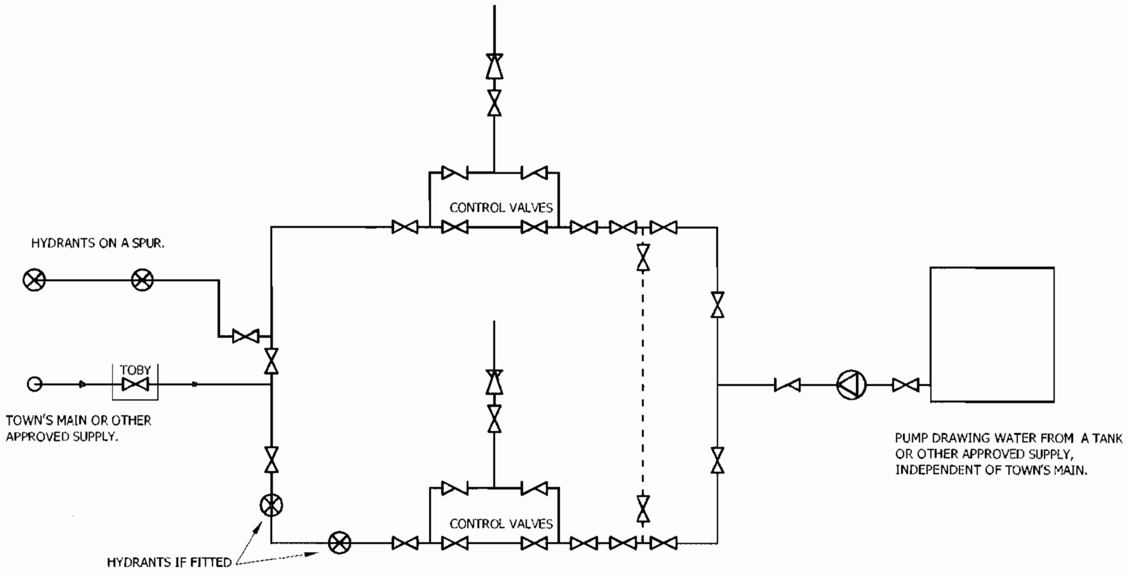
(a) A town's main, boosted town's main, or supplemented town's main provided that any pump is driven by a diesel engine;

(b) A diesel engine driven pump taking water from an approved source other than a town's main;

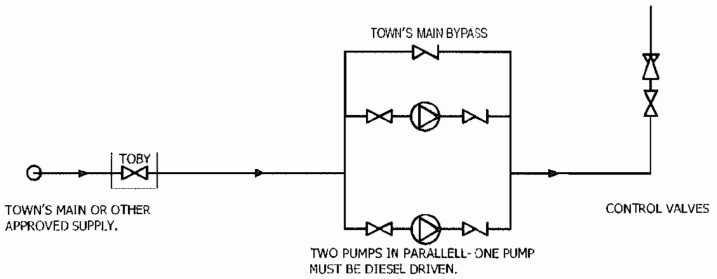
(c) An elevated tank.


TOBY
TOWN'S MAIN OR OTHER APPROVED SUPPLY.
CONTROL VALVES
PUMP DRAWING WATER FROM A TANK OR OTHER APPROVED SUPPLY, INDEPENDENT OF TOWN'S MAIN.

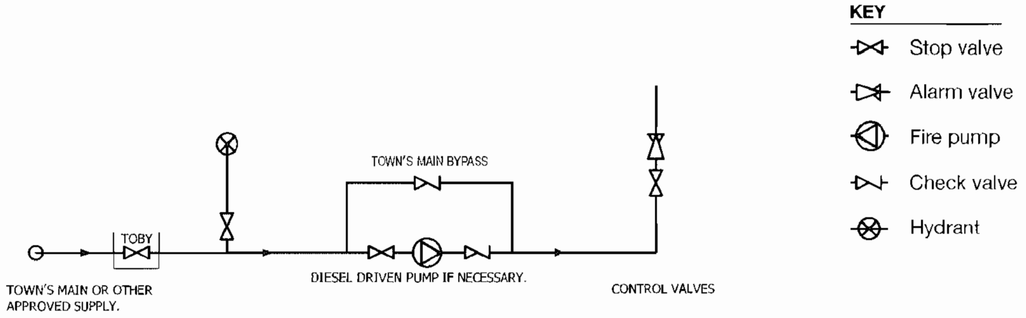
TYPICAL CLASS A SUPPLY


HYDRANTS ON A SPUR.
TOBY
TOWN'S MAIN OR OTHER APPROVED SUPPLY.
CONTROL VALVES
CONTROL VALVES
HYDRANTS IF FITTED
PUMP DRAWING WATER FROM A TANK OR OTHER APPROVED SUPPLY, INDEPENDENT OF TOWN'S MAIN.

TYPICAL CLASS B2 SITE FIRE MAIN


TOWN'S MAIN BYPASS
TOBY
TOWN'S MAIN OR OTHER APPROVED SUPPLY.
CONTROL VALVES
TWO PUMPS IN PARALLELL- ONE PUMP MUST BE DIESEL DRIVEN.

CLASS C2 SINGLE SUPERIOR SUPPLY



CLASS C1 SINGLE SUPPLY

Figure 6.1 – Water supply classes – Typical diagrammatic layouts

602.3 Secondary supply

A secondary supply shall be one of the following:

(a) A town's main, boosted town's main, or supplemented town's main where any pump is either diesel engine or electric motor driven;

(b) A diesel engine or electric motor driven pump taking water from an approved source other than a town's main;

(c) An elevated tank.

602.4

Every water supply shall:

(a) Automatically provide water at least at the design flows and pressures specified in 603;

(b) In cases other than town's mains, boosted town's mains or supplemented town's mains, have a storage capacity of at least that specified in 606;

(c) Meet the requirements of 604, 605, 606, 607, 608 or 609 as they relate to the particular water supply (see figure 6.2);

(d) Except in the case of town's mains, be under the direct control of the owner of the protected building. Where this is not practical, approval may be given to a legally binding arrangement which suitably guarantees the right of use of the building owner to the water supply.

NOTE –

(1) The use of salt or brackish water is not normally allowed. In special circumstances where there is no suitable fresh water source available, consideration may be given to the use of salt or brackish water, provided the installation is normally charged with fresh water.

(2) Attention is drawn to the need to comply with the requirements of the New Zealand Building Code Clause G12.

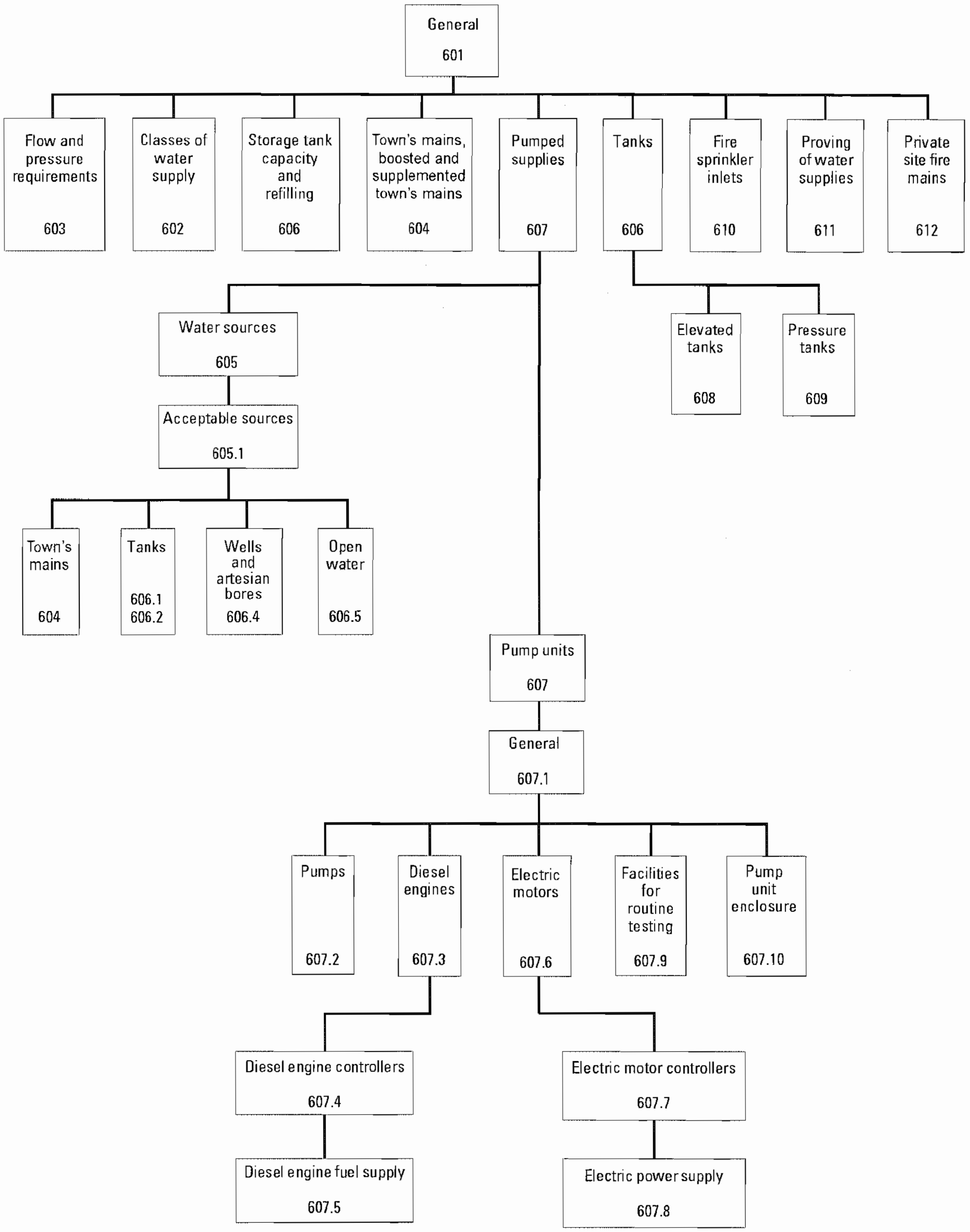


Figure 6.2 – Diagrammatic key to water supply requirements

602.5 Minimum water supply requirements

602.5.1 *Class A and B2 water supplies*

A Class A or Class B2 water supply as defined in 602.1 is required for the following buildings:

(a) Buildings greater than 25 m high, measured from the point of lowest entry to the floor level of the highest normally occupied floor, and located in areas having a hazard factor *Z*, greater than 0.13 (as defined in NZS 1170.5). For further information, see Appendix H;

(b) Buildings or groups of buildings used for crowd or sleeping occupancies, with a total floor area of more than 11,000 m^2, unless the building is subdivided into sprinkler protected floor areas of 11,000 m^2 or less by one of the following:

  (i) Walls having a FRR of 60/60/60

  (ii) External walls at least 10 m from the external walls of other buildings

  (iii) Combinations of (i) and (ii).

602.5.2 *Class C2 water supply*

A Class C2 water supply, as defined in 602.1 is the minimum required for buildings greater than 25 m high, measured from the point of the lowest entry to the floor level of the highest normally occupied floor, and located in areas having a hazard factor *Z*, equal to or less than 0.13 (as defined in NZS 1170.5). For further information, see Appendix H.

602.5.3 *Class C1 water supply*

A Class C1 water supply as defined in 602.1 is the minimum requirement for all buildings not described in 602.5.1 or 602.5.2.

NOTE – A Class C1 water supply is the only supply required for a sprinkler system to comply with the Compliance Documents of the New Zealand Building Code.

603 FLOW AND PRESSURE REQUIREMENTS

The flow and pressure requirements for each installation shall be defined at a point immediately above the alarm valve and shall be those specified in Parts 7, 8 and 9 as appropriate to the hazard plus the requirements of any internal drenchers or, proscenium opening drenchers. Where external sprinklers or deluge systems, or a drencher system installed for Building Consent purposes which utilises the same water supply and imposes a greater requirement then this requirement shall be provided.

Except for internal drenchers installed for building consent purposes and proscenium opening drenchers, systems shall not be required to be designed to deal with internal and external concurrent demands.

604 TOWN'S MAINS, BOOSTED TOWN'S MAINS, SUPPLEMENTED TOWN'S MAINS

604.1 Town's mains

A water supply may be obtained by means of a piped connection from a town's main which meets the following requirements.

604.1.1

The town's main shall be part of a reticulation system under the control of the Network Utility Operator and which has been approved by a Sprinkler System Certifier (SSC) after first determining that the system:

(a) Is in good order with a record of reliable drought free operation;

(b) Is supplied by an inexhaustible source of water or has sufficient stored capacity to meet the normal needs of the area served for a 24 hour period during peak demand;

(c) Has, where pumps are used to provide or supplement pressure, at least 50 % of the pumping capacity independent of the local Network Utility Operator for its electrical power supply.

NOTE – Town's mains are likely to be significantly impaired following a maximum credible earthquake event. The building owner may wish to consider a more reliable water supply to cater for such an event.

The flow and pressure characteristics of a town's main shall be determined by method 1 or method 2 of Appendix C. Based on past history a SSC may nominate the use of method 2 at design parameter review.

If the static pressure of the main exceeds 1,000 kPa, full particulars shall be submitted to a SSC including any proposed use of automatic pressure control valves.

604.1.2

On a class C1 or C2 system, two such connections may be made to the reticulation network and combined to produce a complying single supply provided that:

(a) A prominent sign warning of the two connections is affixed to the block plan and both connections are shown;

(b) An engraved metal sign is affixed to the underside of the toby box lid of both street valves drawing attention to the existence and location of the other valve;

(c) The Network Utility Operator consents; and

(d) If check valves or backflow prevention devices are installed in each connection there shall be a labelled pressure gauge located at the control valves showing the pressure upstream of each check valve/backflow prevention device in accordance with 406.2. If the check valves or backflow prevention devices are installed in a remote location (such as at the boundary), the gauges shall be located at the control valves. The connections may be run in a suitably pressure rated small bore plastic tube. Attention is drawn to the need to ensure that this tube is not subject to freezing.

604.1.3

Where it is proposed to make two connections to a private site fire main to provide a Class B2 supply (see 612), the flow and pressure available at each point of connection shall meet the design requirements and, in addition, there shall not be any one section or component of the reticulation on which both points of connection depend. Hence:

(a) The mains shall be part of different reticulation systems; or

(b) The mains shall form part of an interconnected reticulation system that:
  (i) Is supplied from at least two reservoirs or pumped sources, and
  (ii) Is fitted with sufficient stop valves so that in the event of a breakdown anywhere in the system, selective closing of these valves will ensure that at least one of the mains can remain operational;

(c) The branch connections to an interconnected reticulation system shall comply with 604.1.8.1(c) and have at least two other valves between them. The location of such valves shall comply with 604.1.8.1(d);

(d) Each branch connection shall be capable of supplying the design flow and pressure;

(e) The reticulation network shall be tested with sufficient valves closed to simulate the hydraulically worst condition of breakdown or repair. The particular configurations of closed valves shall be approved.

604.1.4

Except in the case of a supplemented town's main, a listed strainer, complying with 404.10, shall be installed on every town's main water supply in the following cases:

(a) Where the design flow is 2,300 L/min or greater;

(b) Where the design flow is less than 2,300 L/min and previous experience or test results indicate a need for a strainer to eliminate particulate matter which could block a sprinkler or other system orifice.

In such cases, the contractor may obtain an early ruling regarding the need for a strainer, by the submission of appropriate information to, or by facilitating demonstrative tests for, a SSC.

Ordinarily, it will not be necessary to require a strainer for an "Extra light hazard" occupancy design flow if the town's main is 100 mm or larger.

604.1.5 *Pipework*

The pipework of a connection to a town's main shall comply with 403.1.1.

604.1.6 *Connections for hose reels and other low demand uses*

Provided the town's main and the branch connection are not less than 100 mm nominal diameter:

(a) A single pipe not larger than a 40 mm internal diameter may be taken off the branch connection from the town's main for low demand purposes only; or

(b) A single pipe not larger than a 40 mm internal diameter may be taken off the branch connection from the town's main for supplying hydraulic hose reels for firefighting purposes. A single pipe not larger than a 40 mm internal diameter may be taken off this 40 mm pipe for low demand purposes in which case there shall be stop valves suitably labelled on each of the supply pipes for hydraulic hose reels and for low demand purposes fixed in close proximity to their common connecting point;

(c) Where the water supplies comprise connections taken from more than one town's main, a pipe or pipes not larger than a 40 mm diameter to supply hydraulic hose reels for fire-fighting purposes only may be taken from the main which conveys the combined supplies from the point at which they are joined together up to the installation control valves. A stop valve suitably labelled shall be fitted on the pipe taken off for hose reel purposes close to the point of its connection with the combined main;

(d) Such connections shall be fitted with a labelled stop valve in close proximity to the point of connection;

(e) Where required by the Building Consent Authority, such connections are fitted with an approved backflow prevention device.

604.1.7 *Connections for industrial and/or high demand use*

Water for industrial, large domestic demands or other purposes requiring a supply greater than 40 mm, may only be taken from the branch connection from a town's main with approval and if all the following conditions are complied with:

(a) All industrial uses are supplied from a single spur from the branch connection;

(b) The spur is provided with a stop valve, complying with 604.1.8.1(d) within the boundary of the protected premises so that the spur may be independently closed;

(c) There is no water meter on the branch connection to the town's main although there may be a meter on the spur and downstream of the valve in (b);

(d) Apart from the street stop valve, there is no other stop valve in the waterway to the sprinkler installation unless they are fitted with a listed supervisory device and their location is specifically approved by a SSC;

(e) There is a listed pressure sustaining valve fitted on the downstream side of the spur stop valve, arranged to modulate the flow to the industrial users to preserve water to the sprinkler system. The pressure sustaining valve shall have a position indicator fitted to show the relative open/closed position of the valve. Stop valves shall be located immediately upstream and downstream to permit testing and servicing. Suitable test facilities and testing instructions shall be provided;

(f) The position of all valves and the industrial uses spur shall be shown on the block plan; and

(g) Where required by the Building Consent Authority, such connections are fitted with an approved backflow prevention device.

604.1.8 *Connection of hydrants*

604.1.8.1

Hydrants including those on risers in multi-storeyed buildings may only be connected to a branch connection from the town's main, provided they comply with the following conditions:

(a) The branch connection is at least 100 mm diameter;

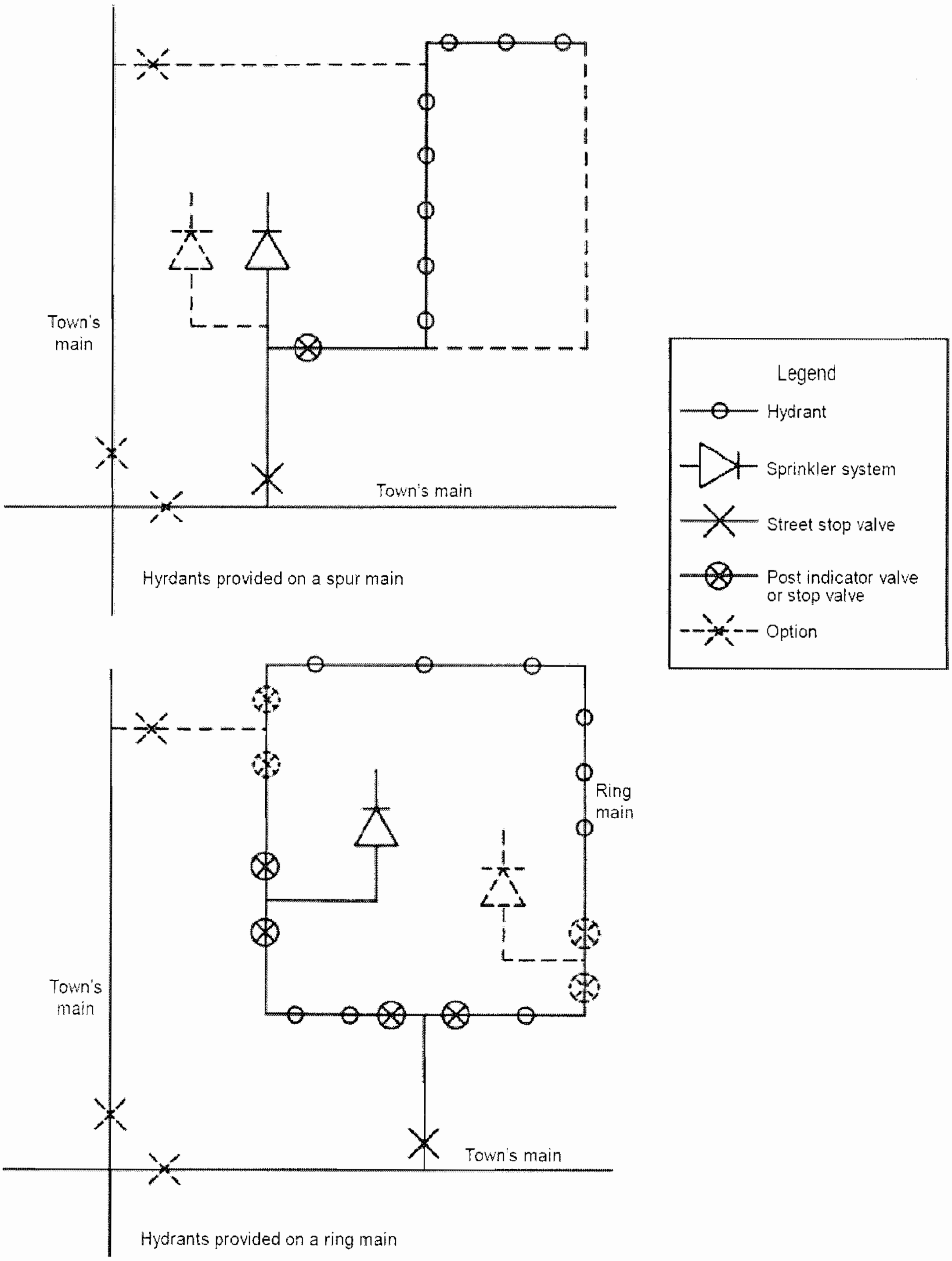
(b) The hydrants are located on a spur, fitted with valves from the branch connection and which may be in the form of a ring and/or may be supplied by more than one connection to a town's main; or

(c) Alternatively, the hydrants and the sprinkler connection are taken directly from a ring main supplied by the branch connection. In this case, normally open valves shall be located on the ring, immediately on either side of the junction with the branch connection, and also immediately on either side of an unvalved connection to each sprinkler installation. No other valves may be located in the ring or the respective branch connections. The ring main may be supplied by more than one connection to a town's main (figure 6.3);

(d) All valves, other than the street valve on each branch connection at the junction with the town's main, shall be listed post indicator valves, or stop valves and toby boxes complying with 604.1.9, or listed stop valves located beneath a suitably sized manhole cover, service duct or accessible part of the building, and shall be locked in the open position and the above ground portions painted red. The hydraulic position of valves shall be as indicated in figure 6.3;

(e) The location of all street stop valves, ring mains, hydrant spur mains and associated stop valves shall be shown on the block plan.

No hydrant may be supplied from any combined main.



Hyrdants provided on a spur main

Hydrants provided on a ring main

Figure 6.3 – Permissible supply to hydrants from town's main sprinkler connections – diagrammatic layout (class C1 supply)

604.1.8.2

Where the fire sprinkler system is supplied from a town's main which has fire hydrants located on that town's main supply hydraulic design allowances will be made in accordance with SNZ/PAS 4509.

(a) The hydrant demand shall be available at the closest two hydrants to the sprinkler valve set when the main is supplying the sprinkler system design demand;

(b) Where the sprinkler system and the hydrants are supplied by an internal ring main (figure 6.3), the pressure availability at the sprinkler valves shall be determined by closing the hydraulically most favourable arm of the ring;

(c) Where the sprinkler system(s) and the hydrant(s) are fed by a ring main i.e. a Class B2 system, the pressure availability at the sprinkler valves shall be determined by closing the hydraulically most favourable arm of the ring, or by the impairment of either of the water supplies.

The hydrant allowance shall be in addition to the sprinkler demand. It is not necessary to provide the demand at the highest design pressure, but merely to be able to demonstrate that the demand is available at a residual pressure of 100 kPa, within 100 % of the sprinkler water supply. See figure 6.4.

In certain cases, the provision of hydrant demand will impose an additional burden on the building owner, where the town's main is not able to provide for both the sprinkler demand plus the hydrant demand. If in such cases, the provision of the hydrant demand would necessitate the provision of a fire water storage tank, the requirement for hydrant demands may be waived if notification is provided in writing to the National Commander of the New Zealand Fire Service with a copy to a SSC. The notification shall give an indication of what the shortfall will be.

604.1.9 *Stop valves and toby boxes*

A left handed closing stop valve enclosed in a toby box shall be provided at the point of connection to the town's main.

NOTE – With the agreement of the Network Utility Operator, the underside of the toby box lid should be painted with a colour distinctive to fire sprinkler connections.

Other than valves installed to allow the isolation of pumps, no other valves may be fitted to the water supply of any sprinkler installation, between this valve and the main stop valve, unless supervised. Underground stop valves on private site ring mains are not required to be supervised.

604.1.10 *Water meters*

Where required by the Network Utility Operator, listed water meters may be installed on the connection to the town's main. See 404.9.

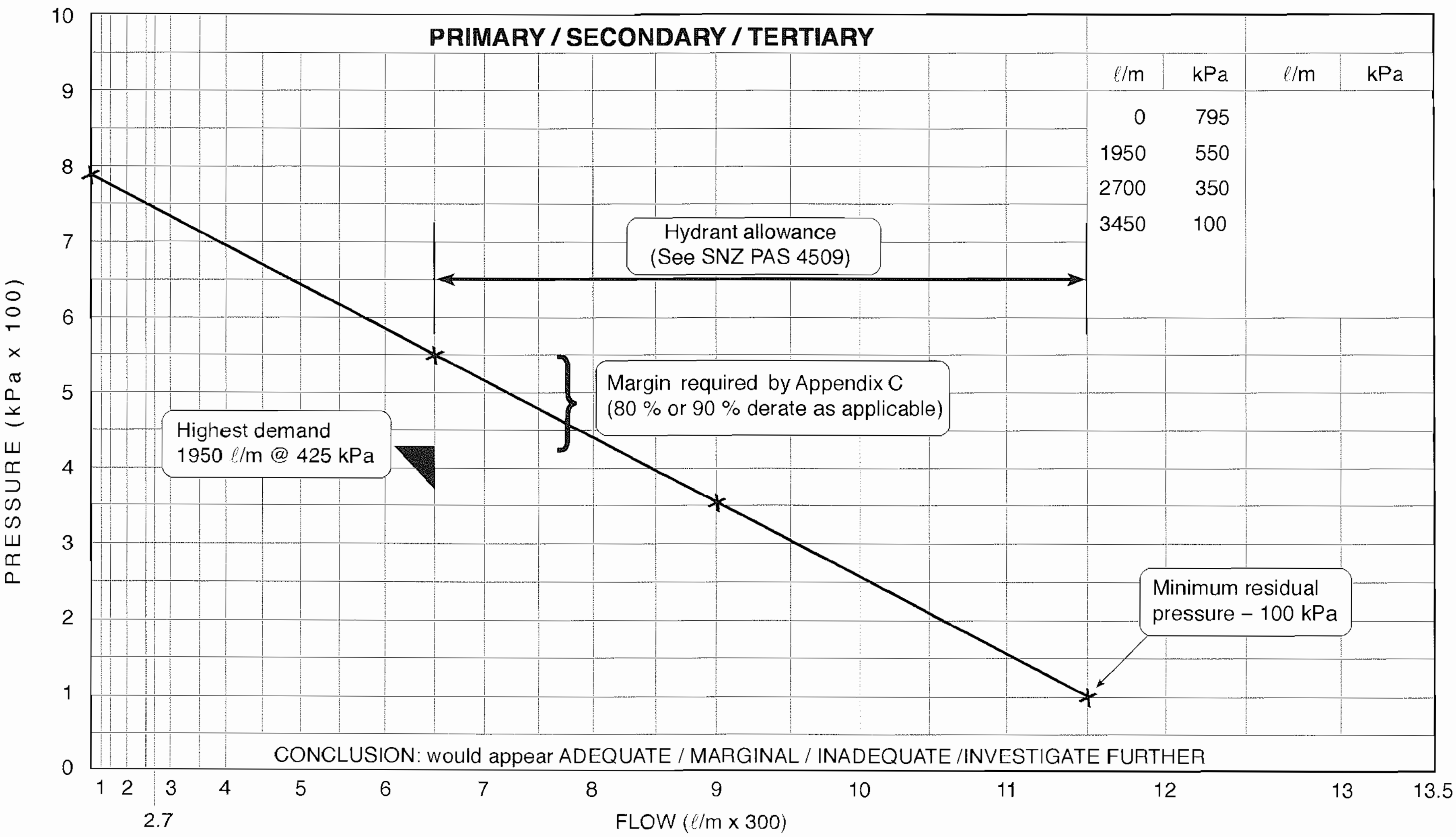
604.1.11 *Private potable water mains to multiple buildings*

Private potable water reticulation mains serving multiple buildings and/or sprinkler systems shall be deemed to comply provided all of the following conditions are met:

(a) The reticulation main must be supplied by at least one approved primary supply;

(b) The reticulation main can be demonstrated to have a similar level of reliability to a town's main;

(c) Where multiple buildings are served by the reticulation main the connections to each building, for other purposes, shall be required to comply with 604.1.6 and 604.1.7 except that one connection shall be permitted per building, or in the case of residential units, one connection per unit.



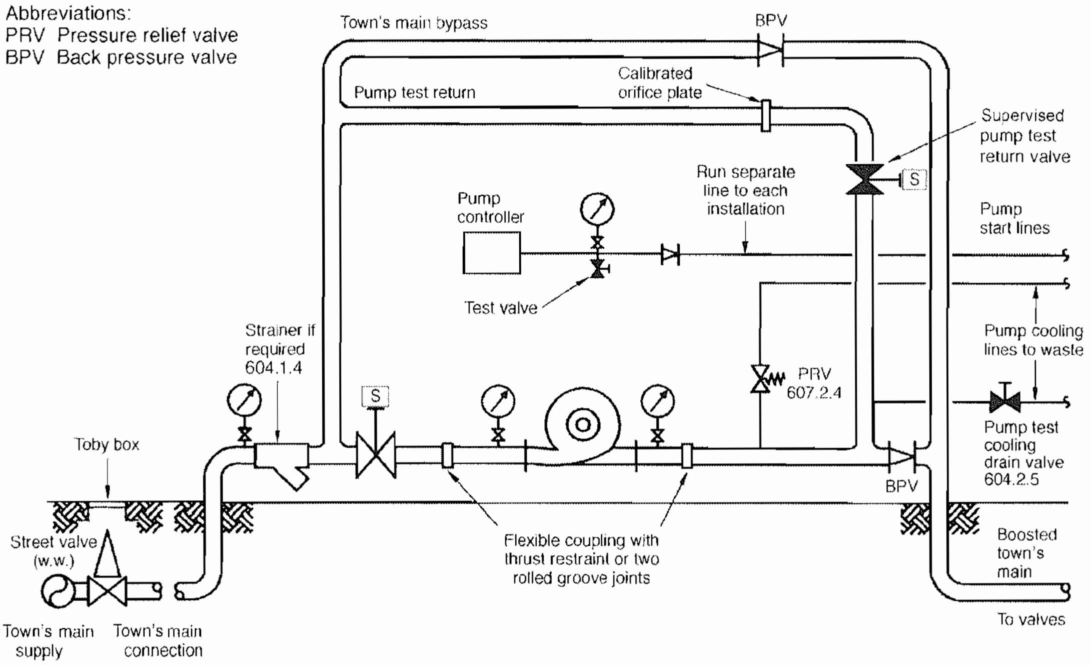
ℓ/m	kPa	ℓ/m	kPa
0	795		
1950	550		
2700	350		
3450	100		

Figure 6.4 – Illustrative example of hydrant allowance (see 604.1.8.2)

604.2 Boosted town's main

604.2.1 *General*

In any situation where a town's main, which otherwise complies, cannot meet the necessary pressure requirements, an automatic starting diesel pump unit or, in the case of a secondary supply, an automatic starting electric pump unit may be used to boost the pressure to meet the relevant design pressure requirements. (See figures 6.5, 6.6 or 6.7 for typical layouts.)


Abbreviations:
PRV Pressure relief valve
BPV Back pressure valve
Town's main bypass
BPV
Pump test return
Calibrated orifice plate
Supervised pump test return valve
Run separate line to each installation
Pump controller
S
Pump start lines
Test valve
Pump cooling lines to waste
Strainer if required 604.1.4
PRV 607.2.4
S
Toby box
Pump test cooling drain valve 604.2.5
BPV
Street valve (w.w.)
Flexible coupling with thrust restraint or two rolled groove joints
Boosted town's main
To valves
Town's main supply
Town's main connection

NOTE – W.W. means water works pattern stop valve.

Figure 6.5 – Typical arrangement for boosted town's main without pressure relief line

604.2.2 *Pump unit*

The combined output of the town's main (when measured in accordance with method 1 or 2 of Appendix C) and pump shall meet the pressure and flow requirements of the system. The pump unit shall comply with 607.

604.2.3 *Town's main pressure*

The residual pressure in the main when meeting the highest design flow shall not fall below 100 kPa at the point of connection to the town's main and shall be positive pressure between that point and the suction point of the pump. This value is not subject to derating in terms of Appendix C.

604.2.4 *Bypass*

A bypass shall be provided around the pump of the same diameter as the town's main connection and shall be fitted with a non-return valve to prevent recirculation.

604.2.5 *Pump test return*

A pump test return pipe shall be taken from the pump delivery (downstream of the flexible coupling) to the pump suction (upstream of the flexible coupling). This pipe shall be fitted with a normally closed, locked and labelled indicating stop valve fitted with a supervisory device. A normally closed pump cooling drain may be required in accordance with 607.2.4, figures 6.5, 6.6, and 6.7. An orifice plate, sized to induce approximately 110 % of the design flow, shall be fitted in the pump test return unless the hydraulic characteristic of the pipework is such as to cause 110 % of the design flow to be induced. The pump test return valve shall be supervised to signal defect when more than 5 % open (see also 607.9).

604.2.6 *Pump discharge pressure control*

Where the boosted discharge pressure from a pump will exceed the rating of the system components or cause difficulties with operation of the system then listed pressure relief or listed pressure reducing valves may be fitted. Typical arrangements are shown in figures 6.6 and 6.7.

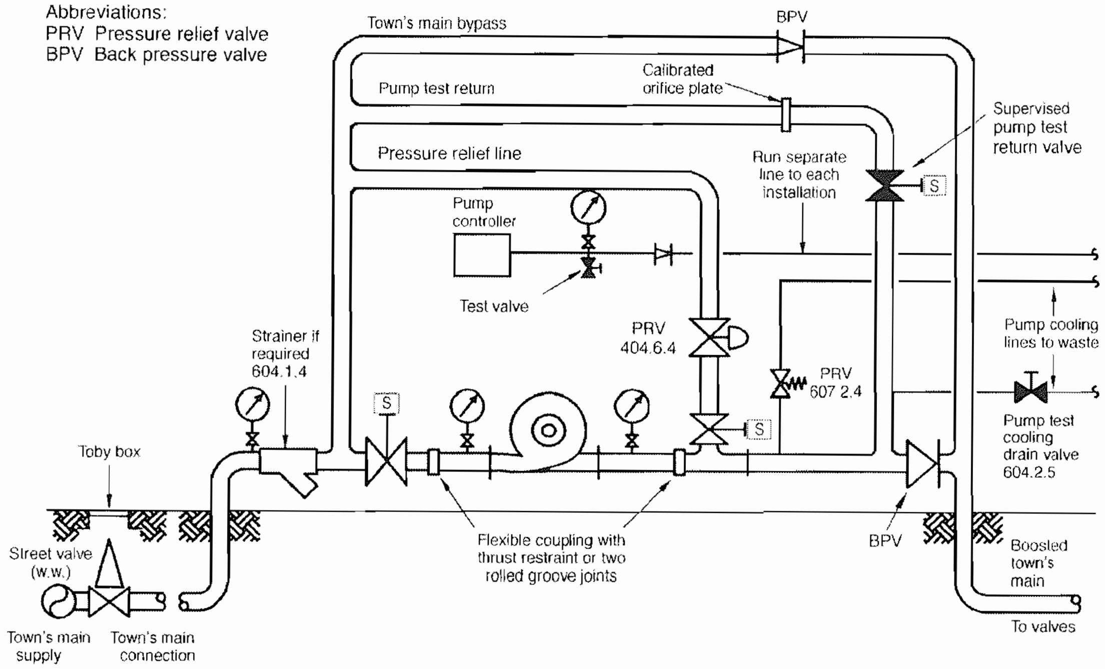


Figure 6.6 – Typical arrangement for boosted town's main with pressure relief line

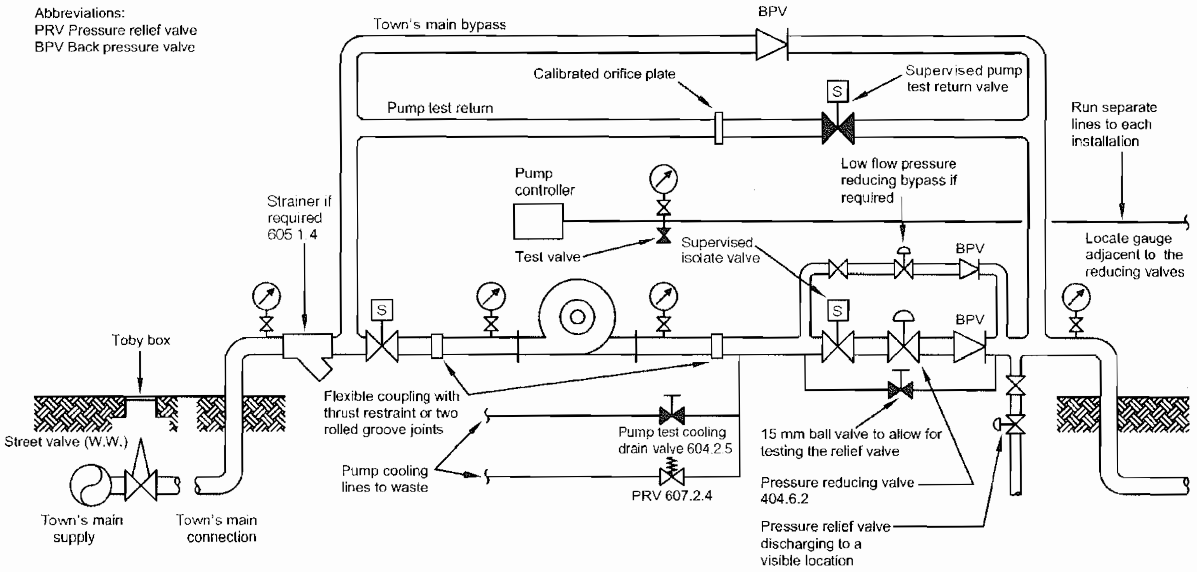

Abbreviations:
PRV Pressure relief valve
BPV Back pressure valve
Town's main bypass
BPV
Calibrated orifice plate
Supervised pump test return valve
S
Pump test return
Run separate lines to each installation
Pump controller
Low flow pressure reducing bypass if required
Strainer if required 605 1.4
Test valve
Supervised isolate valve
BPV
Locate gauge adjacent to the reducing valves
S
S
BPV
Toby box
Flexible coupling with thrust restraint or two rolled groove joints
Street valve (W.W.)
Pump test cooling drain valve 604.2.5
15 mm ball valve to allow for testing the relief valve
Pump cooling lines to waste
PRV 607.2.4
Pressure reducing valve 404.6.2
Town's main supply
Town's main connection
Pressure relief valve discharging to a visible location

Figure 6.7 – Typical arrangement for boosted town's main with pressure reducing valve system

NOTE –

(1) Low flow pressure reducing bypass may be required to allow stable pressure control at single head flow. This valve is typically set a minimum of 100 kPa above the main reducing valve set pressure. Consult with valve manufacturer to correctly engineer this valve.

(2) A pressure relief valve is required downstream of the pressure reducing valve to cater for transient surges. The pressure relief valve is to be piped to waste. The use of a pilot-operated relief valve is recommended.

604.3 Supplemented town's main (using in-fill tank)

604.3.1 *General*

In any situation where a town's main, which otherwise complies, cannot meet the necessary flow requirements, an in-fill tank and automatic starting diesel engine driven pump unit or, in the case of a secondary supply, an automatic starting electric pump unit may be used to provide the relevant design flow requirements for the required period of discharge.

604.3.2 *Tank*

The following requirements apply:

(a) The tank shall comply with the requirements of 606.1 – 606.3 other than those of 606.2.3;

(b) The tank shall be filled by the town's main. The filling pipe shall terminate below the level of the anti-vortex plate. Adequate arrangements shall be made to prevent inflow turbulence creating air entrainment in the pump suction at all tank levels within the design capacity;

(c) The inflow shall be controlled by a listed automatic valve operated by an approved pilot control arrangement so that a lowering of the water level more than 75 mm below the overflow will fully open the inflow. The automatic valve shall close before the tank overflows. The arrangement shall have regard to wave action and the need to be tested and the overflow pipe shall have a cross-sectional area at least twice that of the in-fill pipe and be capable of preventing the water level rising above the overflow pipe;

(d) A 15 mm nominal diameter connection controlled by a ball valve and float in parallel to the main inflow valve may be provided to facilitate topping up;

(e) The tank shall be of sufficient capacity and the automatic in-fill flow rate sufficiently large that, taken together, the pump can deliver the design flow for the times specified below, without the town's main residual pressure falling below 100 kPa at the inlet to the automatic control valve;

Supply	Extra light and ordinary hazard	Extra high hazard
Primary supply	60 minutes	See table 6.1
Secondary supply	40 minutes	

(f) Where the flow requirement for external sprinklers exceeds that for the hazard classification within the protected area, the tank and main capacity combined shall also be capable of meeting the specified minimum operating times (see also 606.1.3);

(g) The capacity shall be measured as the depth of water contained between a horizontal plane 50 mm below the overflow, and the level below which air entrainment due to in-flow turbulence may occur or the level of the anti-vortex plate, whichever is the higher;

(h) Where the water storage tank provides water supply to fire hydrants the tank capacity shall be increased by 45 m^3.

NOTE – In certain circumstances consideration should be given to increasing the volume for hydrants where external fires may occur.

604.3.3 *Pump unit*

The pump unit shall comply with 607.

604.3.4 *Town's main*

The town's main in-fill shall incorporate, for the purposes of testing and checking, a labelled pressure gauge and a stop valve controlled test connection with one or more permanent test connections complying with 610.5.7. There shall be a supervised stop valve between the automatic valve and the discharge pipe into the tank which shall be closed for testing and checking of the in-fill rate and automatic valve functions. The test connection take off shall be between the automatic valve and the supervised stop valve.

605 PUMPED SUPPLIES – WATER SOURCES

605.1 Acceptable sources

The following are acceptable sources of water for pump units, provided they satisfy the detailed requirements set out in this Standard:

(a) Town's mains (see 604);

(b) Tanks (see 606.1 – 606.3);

(c) Wells and artesian bores (see 606.4);

(d) Open water (see 606.5).

In each case, the water shall be clean and free from sediment and debris.

605.2 Town's mains

Town's mains supplying water for a pump shall meet the requirements for boosted or supplemented town's mains.

605.3 Tanks

See figure 6.8.

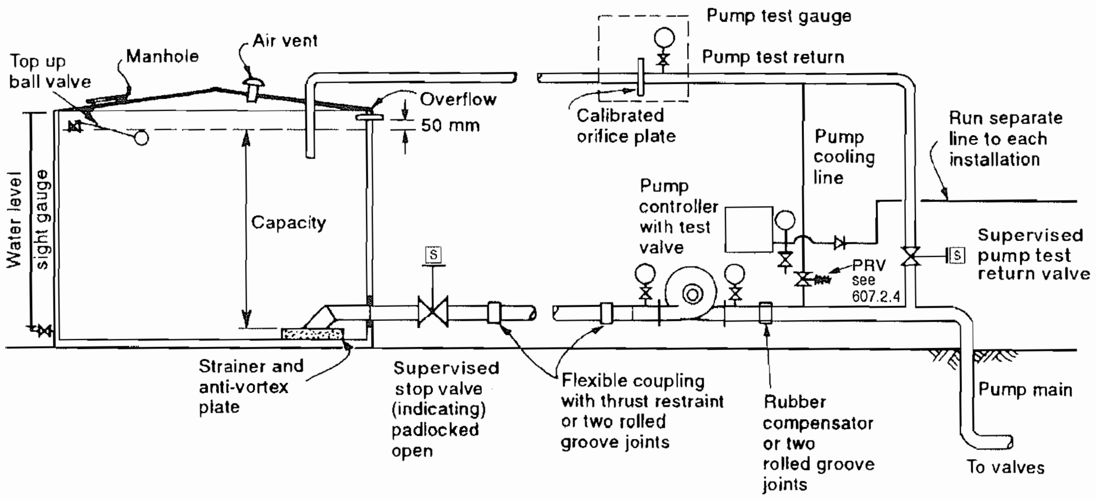

Pump test gauge
Pump test return
Top up ball valve
Manhole
Air vent
Overflow
50 mm
Calibrated orifice plate
Pump cooling line
Run separate line to each installation
Water level sight gauge
Capacity
Pump controller with test valve
S
Supervised pump test return valve
PRV see 607.2.4
Strainer and anti-vortex plate
Supervised stop valve (indicating) padlocked open
Flexible coupling with thrust restraint or two rolled groove joints
Rubber compensator or two rolled groove joints
Pump main
To valves

Figure 6.8 – Typical arrangement for pump and tank supply

606 WATER STORAGE

606.1 Storage tank capacity

606.1.1

Where a water supply incorporates a storage tank, the minimum effective capacity shall be the product of the greatest design flow and the time (as specified below) during which that flow shall be delivered. Where the water storage tank provides water supply to fire hydrants the tank capacity shall be increased by 45 m^3.

Hazard classification	Primary supply	Secondary supply
Extra light	60 min x design flow	40 min x design flow
Ordinary	60 min x design flow	40 min x design flow
Extra high	table 6.1	table 6.1

NOTE –

(1) For in-fill tanks associated with supplemented town's mains, see 604.3.

(2) Where external sprinklers are provided see also 606.1.3.

(3) In certain circumstances consideration should be given to increasing the volume for hydrants where external fires may occur.

606.1.2

The effective capacity shall be measured as follows:

(a) Where the storage tank or elevated tank is used exclusively as a water source for the sprinkler supply, the capacity shall be measured between a horizontal plane 50 mm below the overflow and the top of the anti-vortex plate;

(b) The capacity of a storage tank or elevated tank that also provides water for other purposes is the volume contained in the depth by which the sprinkler anti-vortex plate is below the other purposes outlet.

Table 6.1 – Duration of water supplies for EHH occupancies

Commodity	**Storage type**	**Height** (m)	**Time primary supply** (min)	**Time secondary supply** (min)
Process occupancies	Other than storage areas	n/a	90	60
Categories 1 to 3	Rack	Any	90	60
Categories 4, 5 & 6	Rack	Any	120	60
Categories 1 to 4	Solid pile, palletised, shelf and bin-box	Up to 3.6	60	60
Categories 1 to 3	Solid pile, palletised, shelf and bin-box	Greater than 3.6	90	60
Category 4	Solid pile, palletised, shelf and bin-box	Greater than 3.6	120	60
Categories 5 & 6	Solid pile, palletised, shelf and bin-box	Any	120	60
Rubber tyres	See 907.1		240	120
Roll paper	See 907.2		120	60
Baled fibres and waste paper	Solid pile (not in racks)	See 907.3	240	120
Hanging garments	See 907.4		60	60
Carpet	See 907.5		120	60
Idle pallets	Group I	See 907.6	90	60
	Group II		120	60
Aerosols	See 907.7		120	60
Distilled spirits	Palletised barrel storage	See 907.8	480	240
	Barrel storage in racks		120	60
	Cased glass bottle storage		90	60
	Cased PET bottle storage		120	60

NOTE –

(1) The water supply duration for CMSA sprinklers shall be to table 6.1.

(2) The water supply duration for suppression mode sprinklers shall be for a minimum of 60 minutes for primary and secondary supplies.

606.1.3

In the case where the design number of external sprinklers create a flow requirement in excess of the hazard classification within the building, the capacity of any storage tank shall be increased, where necessary, as follows:

(a) Where the exposure consists of a private dwelling or other structure of similar size, there shall be sufficient storage for 30 minutes discharge at the highest design flow imposed by the design number of external sprinklers;

(b) In other cases, so that there is sufficient storage for 60 minutes discharge at the highest density flow imposed by the design number of external sprinklers.

606.2 Refilling and topping up

606.2.1

Provision shall be made on all storage tanks and elevated tanks to:

(a) Automatically keep the tank topped up;

(b) Manually refill the tank after emptying.

606.2.2 *Topping up*

Topping up may be by either:

(a) A float operated valve or other suitable device controlling a 15 mm NB pipe connected to a town's main; or

(b) An electrically driven 20 L/min pump taking suction from a reliable source, automatically switched by a level controlled switch;

Where (a) or (b) cannot be achieved, topping up may be provided by a continuous overflow controlled supply from rainwater or other less reliable source.

606.2.3 *Refilling*

The following requirements apply:

(a) Refilling may be provided by a connection to a town's main, provided that this will not deplete a town's main supply to the system in the event of the system operating, or from some other reliable source of water;

(b) Refilling shall be achieved within the following times:

Tanks up to 500 m^3	6 h
Tanks of larger capacity	12 h;

(c) If the refilling time specified above cannot be met alternative contingency plans shall be submitted for consideration to a SSC.

606.2.4 *Rainwater*

Where rainwater or other unfiltered water is used to provide topping up or refill, it shall first pass through a debris and sludge trap.

606.2.5 *Float operated valves*

Float operated valves shall be accessible for maintenance without requiring significant water storage depletion.

606.3 Construction

606.3.1 *Design and manufacture*

Tanks of the following types may be used provided they are either of a design and manufacture approved by a professional structural engineer or comply with the appropriate Standard:

(a) Roofed concrete tanks (constructed in accordance with NZS 3106);

(b) Roofed wooden tanks (constructed in accordance with ANSI/NFPA 22);

(c) Roofed steel tanks constructed of stainless or protected mild steel;

(d) Any other tank where evidence is provided in the form of a design certificate from a chartered engineer;

(e) Swimming pools which meet the requirements of the TA, provided that:

   (i) The drain valve is chained and padlocked shut, and labelled in 12 mm high white letters on a red background "FIRE SPRINKLER PUMP WATER SUPPLY. DO NOT DRAIN BEFORE NOTIFYING SPRINKLER CONTRACTOR"

   (ii) A grating additional to the suction inlet strainer is installed to prevent foreign matter reaching the strainer

   (iii) The water is kept clean at all times by an effective filtration unit

   (iv) The purification system does not utilise sodium chloride or other corrosive materials;

(f) An embankment-supported membrane pillow tank constructed in accordance with Appendix O;

(g) A polyethylene tank constructed to AS/NZS 4766 and secured fixed via built-in tie-down lugs formed into the tank to comply with NZS 1170.5 seismic resistance. The maximum size of any polyethylene tank is to be 30 m^3.

606.3.2 *Location and support*

The following requirements apply:

(a) Tanks should be placed in positions that are not likely to be exposed to fire;

(b) They shall be supported on adequate foundations, at or below ground level; and

A1 (c) Tanks shall be constructed to meet the requirements of NZS 4219 or NZS 1170.5 with respect to seismic design.

606.3.3 *Access*

Access, secured against unauthorised entry, shall be provided to inspect and maintain the fittings and fixtures of every tank.

606.3.4 *Indicator*

The tank shall be fitted with an indicator showing the contents above the level of the vortex plate.

606.3.5 *Overflow pipe and air vent*

A tank overflow pipe of suitable size shall be provided which discharges in an observable place. An air vent of suitable size shall be fitted.

606.3.6 *Freezing protection*

In situations where freezing of water is likely, the tank, together with the inlet and suction pipes, pumps test return and level indicator shall be protected against freezing.

606.3.7 *Suction pipe inlet*

All suction pipes shall commence with:

(a) A screen having a net cross section open area of 4 times the cross sectional area of the suction pipe and openings in the screen shall not have a major dimension larger than 8 mm; and

(b) An anti-vortex plate having a minimum dimension, measured from the centre of the outlet pipe to the outside edge of the plate, of 0.4 m for design flows up to 2,000 L/min and 0.6 m for greater design flows; or

(c) An anti-vortex plate complying with (b), and a strainer complying with 404.10, installed immediately downstream of the stop valve identified in 606.3.8(b).

606.3.8 *Suction pipe*

The following requirements apply:

(a) The size and position of the suction pipe shall be such that, at the highest design flow, the water velocity does not exceed 4.0 m/s and the total pressure loss between the entry to the suction pipe and the inlet of the pump (including any permissible static lift) does not exceed the net positive suction head required minus 20 kPa when the water is at the level of the anti-vortex plate;

(b) A supervised stop valve fitted with an open and shut indicator and chained and padlocked open shall be located in the suction pipe upstream of any flexible coupling;

(c) Butterfly valves shall not be placed within 10 pipe diameters of the pump suction inlet;

(d) The suction pipe should be laid such that no air may be trapped in it. Where this is impracticable, provision shall be made for the automatic release of trapped air;

(e) Provision shall be made to accommodate differential settlement and seismic movement between the tank and pump, and between tanks where multiple tanks are interconnected.

See also 607.2.3 and figure 6.9.

NOTE – The velocity limitation specified in this clause does not apply to the 10 pipe diameter length of pipe attached directly to the pump casing, as specified in 607.2.3(d).

606.3.9 *Flooded suction*

The location of the tank and suction pipe with respect to the pump shall be such that the centreline of the suction inlet of the pump is below 60 % of the required stored water capacity in the tank and at least 650 mm below the overflow and any other-purposes outlet on the tank.

606.3.10 *Priming devices and foot valves*

Automatic priming devices and foot valves are not permitted.

606.3.11 *Pump test return*

A pump test return shall be taken from the pump delivery (downstream of the flexible coupling) to the tank. This pipe shall terminate below the normal water level in the tank so no air entrainment will take place during the pump testing.

When it is not practicable to pipe the test return back to the tank then, with specific approval, the test line shall be piped back into the pump suction pipe such that it enters the suction pipe at an angle of 90° at least 10 pipe diameters upstream of the pump suction flange.

The test return pipe shall be fitted with a normally closed, locked and labelled stop valve fitted with a supervisory device. An orifice plate, sized to induce approximately 110 % of the design flow, shall be fitted in the pump test return unless the hydraulic characteristic of the pipework is such as to cause approximately 110 % of the design flow to be induced. The pump test return valve shall be supervised to signal defect when more than 5 % open (see figure 6.8 and 607.9).

606.4 Wells and artesian bores

606.4.1 *Approval required*

Wells and artesian bores may be used as a source of water for a pump unit only with SSC approval. Any application for approval shall set out full details of the hydrological history of the proposed aquifer or one close to it and provide details of the water quality and well design.

606.4.2 *Well development*

The well development flow shall be at least 150 % of the highest design flow. At completion of development at such flow, the number of sand grains lifted shall not exceed 50 per litre.

606.4.3 *Well construction and accessories*

The following requirements apply:

(a) The well shall have a screen with a sealed bottom;

(b) The velocity of water through the screen shall not exceed 50 mm/s;

(c) Foot valves are not permitted;

(d) The top of the inlet to the pump or dip pipe shall be submerged at least 2 m at all conditions of flow up to and including the highest design flow;

(e) An approved device to measure draw down level under all flow conditions shall be permanently fitted;

(f) Adequate facilities shall be available for withdrawal of the dip pipe and, where needed, submersible pump.

606.4.4 *Pumps*

Where submersible pumps are used, attention is drawn to the need to comply with the requirements for vertical shaft pumps and submersible electric pumps.

Where an artesian well provides the highest design flow at the surface, above-ground pumps may be used provided that such flow is delivered to the pump at a pressure of at least 10 kPa.

606.4.5 *Pump test return*

A pump test return similar to that described in 606.3.11 shall be installed. The point of discharge should be back to the well casing.

606.5 Open water

606.5.1 *Approval required*

With approval and subject to any conditions imposed, water for a pumping unit may be taken from a river, lake, pond or reservoir for which an appropriate water right is held.

606.5.2 *Design details*

Full details shall be submitted to a SSC concerning:

(a) Quality of the water;

(b) Design of the suction pit, settlement chamber and water entry;

(c) Capacity and available flow at all times;

(d) Flood protection arrangements;

(e) Lowest and highest known water levels.

606.5.3 *Flooded suction*

The lowest known water level of the water source shall be at least 650 mm above the pump centre line.

606.5.4 *Pump test return*

A pump test return similar to that described in 606.3.11 shall be installed. The point of discharge should be back to the water source.

Should the water source be a considerable distance away from the pump then, with a SCC approval, a pump test return similar to that described in 604.2.5 may be used (see also 607.9).

607 PUMPED SUPPLIES – PUMP UNITS

607.1 General

607.1.1 *Pump selection*

The published manufacturer's curve of the selected pump shall demonstrate that:

(a) At the design flow of every installation supplied, the pump will produce 110 % of the additional pressure needed, at the point of connection to the water supply of the pump inlet flange, in order to meet the highest design pressure of each installation at the control valves, plus the pressure losses (or gains) due to difference in height and due to friction between the pump delivery and each alarm valve.

In determining the pressure available at the pump suction, the following shall be allowed for:

(i) On tanked or open water supplies, the pressure loss due to friction at the highest design flow in the suction pipe between the tank and the pump suction, plus allowance for the difference in elevation of the pump suction and the level of water (in tanks, when both full and empty).

(ii) For boosted town's mains, the pressure differences due to friction loss (at the highest design flow) and due to static height, between the point at which the pressure measurement is taken to determine the characteristics of the town's main and the suction inlet of the pump;

(b) The "Net positive suction head (NPSH) required" at the highest design flow is not more than the "NPSH available" minus 20 kPa at the suction inlet, measured or calculated as an absolute pressure having regard to the water temperature;

(c) At 150 % of the highest design flow, the pump will produce at least 65 % of the pressure available (on the manufacturer's curve) at the design flow and, when driven by the selected driver the pressure will fall progressively with the rate of flow.

NOTE – In this context, the expression "design flow" means whichever is the larger of:

(1) The flow rate required to supply all sprinklers discharging over the assumed area of operation to provide the design density or otherwise provide the flow required for control mode specific application or supression mode sprinklers; or

(2) The flow rate required to operate any water spray or deluge system forming part of the sprinkler system; or

(3) If the pump also provides water for a fire hydrant system (as permitted by the Standard), the flow rate required to supply the sprinklers or water spray or deluge system plus hydrant demand.

(4) Any flow rate discharged or recirculated to control pump discharge pressure should be added to the flow rates required in 1, 2 or 3.

607.1.2 *Component parts*

A pump unit consists of a listed pump, listed motor, listed controller and a unit frame.

607.1.3 *Unit manufacture*

Pump units shall be manufactured by a manufacturer or contractor listed for that purpose and:

(a) When ordering a pump unit, a schedule of relevant information, including the data specified in Appendix D, shall be advised to the unit manufacturer;

(b) Before dispatch from the manufacturer's premises, every pump unit shall be inspected for compliance, including operation of control functions, and for units up to 100 kW a flow test (for larger units see 607.2.2).

607.1.4 *Pump coupling and mounting*

The pump unit and driver shall be assembled so that:

(a) The mounting on the frame shall allow either driver or pump to be removed without disturbing the other and the impeller to be withdrawn without removing the driver or pump body;

(b) There shall be ready access for checking the alignment of resilient couplings when the installation is complete;

(c) Cement grout or oil resistant flexible pads shall be provided under the frame unless the manufacturer's instructions state otherwise. Care shall be taken not to distort the frame when bolting it down;

(d) The alignment shall be checked to be in accordance with the manufacturer's specification after the pump frame is installed, bolted down and pipework connected;

(e) The pump and driver shall be in line direct or close coupled, and the coupling shall be rated for the maximum torque of the driver under all conditions, and of a design such that if any elastomeric element used in the coupling to absorb vibration should fail, that the pump shall continue to be driven under all operating conditions, except that a right angle gear drive may be used for vertical shaft pumps.

607.1.5 *Automatic starting*

Automatic starting shall be provided so that:

(a) It shall be initiated by a listed pressure switch having dual enclosed contacts in parallel, that close on drop in pressure;

(b) Start pressure switches shall be located on the controller;

(c) Every time a drop in pressure closes the contacts of a start pressure switch, the pump, if it is not already running, shall start;

(d) The pump start arrangement shall comply with the requirements of either 607.1.5.1 or 607.1.5.2.

607.1.5.1 *Individual installation start arrangement*

This form of start arrangement has each sprinkler installation connected separately to the water supply pump(s) controller by an hydraulic pipe to sense a drop in pressure in that installation. The following requirements apply:

(a) A start pressure switch shall be provided for each sprinkler installation supplied by the pump;

(b) The start pressure switch shall be pressurised through a hydraulic line with a check valve (opening away from the pressure switch) in which a 2 mm orifice or equivalent score across the valve seat has been made. The hydraulic line shall also incorporate a test valve piped to drain and pressure gauge arranged to permit accurate setting and testing of the pressure switch, unless, within easy reading distance, other test apparatus will serve the same purpose. Where a distant pump enclosure necessitates long hydraulic connections, such connections may be run in high density polyethylene pipe provided that the check valve is located close to the control valves;

(c) The start pressure switch shall close before the pressure drops below that required to provide the most hydraulically remote 6 sprinkler heads operating;

NOTE – In most cases it will not be necessary to calculate the start pressure if it is possible to set the pump start pressure switch above the highest design pressure.

(d) Where there are both electric motor and diesel engine driven pumps then:

  (i) Where there are two storage tanks, the electric motor driven pump is to start first

  (ii) If there is a storage tank plus one other type of water source of unlimited capacity (e.g. a town's main) the pump on the unlimited capacity source is to start first;

(e) This method of starting shall not be used for dry pipe, deluge or preaction installations.

607.1.5.2 *Water supply manifold start arrangement*

This form of start arrangement senses a drop in pressure of the sprinkler system water supply main to initiate the pump(s) starting. The following requirements apply:

(a) A start pressure switch shall be provided with connection downstream of the pump discharge check valve;

(b) The start pressure switch shall be pressurised through a hydraulic line with a check valve (opening away from the pressure switch) in which a 2 mm orifice or equivalent score across the valve seat has been made. The hydraulic line shall also incorporate a test valve piped to drain and pressure gauge arranged to permit setting and testing of the pressure switch;

(c) The start pressure switch shall close before the pressure drops below that required to provide the most hydraulically remote 6 sprinkler heads operating;

NOTE – In most cases it will not be necessary to calculate the start pressure if it is possible to set the pump start pressure switch above the highest design pressure.

(d) The pressure downstream of the pump discharge check valve shall be maintained at a pressure above the pump start pressure switch setting, but below the lowest FIRE pressure switch setting for any installation served by the pump. If this requires the use of an automatic jockey pump, it is recommended that this be served by an essential service switchboard serving the site;

NOTE – For B2 supplies, 612.3 requires the pressurisation to be maintained for 24 hours without the standard power supply.

(e) Where there are two storage tanks, the electric motor driven pump is to start first;

(f) Where there is a storage tank plus one other type of water source of unlimited capacity (e.g. a town's main) the pump on the unlimited capacity source is to start first;

(g) This method of starting shall be used for dry pipe, pre-action or deluge installations.

607.1.6 *Manual starting*

A labelled green manual start button shall be provided on the controller to energise directly the starter contactors.

607.1.7 *Stopping and isolation*

Once started, every pump unit shall run until manually stopped at the pump unit. The use of a failsafe device such as an 'energised to stop' solenoid is accepted as meeting these requirements providing it meets the other requirements of this clause. Automatic or remotely operated stopping is not permitted. The following facilities shall be provided:

(a) A red, clearly labelled, easily accessible stopping device that automatically resets or returns to its normal position;

(b) Manual means of individually isolating each start pressure switch. Only pressure switches that are closed may be isolated. Reopening the pressure switch shall automatically cancel the isolation.

607.1.8 *Gauges*

The following gauges shall be provided:

(a) A pressure gauge complete with gauge cock connected to the suction of every pump far enough from the pump not to be influenced by pump entry turbulence;

(b) A pressure gauge complete with gauge cock connected to the pump delivery;

Gauges shall comply with 406.

607.1.9 *Pump running indicator*

Every pump unit shall be provided with a device which indicates at an approved location that the pump is running. On diesel engine driven pumps, a SSC may agree to the omission of this alarm if the noise of the engine will serve the same purpose. A self-resetting device may be incorporated to suppress an electrically operated alarm for up to 60 minutes. Where the indication is made at a location which is not manned at all times, a defect signal shall be generated through the fire brigade alarm (FBA). The FBA control box used to generate the defect signal shall be clearly marked "Pump running alarm connected to this unit."

607.1.10 *Pressure relief valves*

Pressure relief valves may be used to limit pump discharge pressure where excessive pressures may be generated. If fitted to boosted town's mains or tank supplies, these valves shall not discharge to waste. See 404.6.4.

607.1.11 *Acceptance of load*

The design flow of the pump unit shall be provided automatically (at the pressure designated on the pump curve) within 30 seconds of the pump start signal when tested under open discharge conditions.

607.2 Pumps

607.2.1 *Listing of pumps*

Only listed rotodynamic pumps shall be used. Factors that shall be considered for any listing are:

(a) Materials and construction;

(b) Performance range and accuracy against the manufacturer's curve;

(c) Availability of documentation.

Every application for listing of a pump shall be accompanied by the following:

(d) Details of construction;

(e) The discharge versus power absorbed at duty speed;

(f) The net positive suction head required (NPSHR) versus discharge at duty speed;

(g) The total head versus discharge at various speeds and impeller diameters; and

(h) The maximum impeller width and diameter.

607.2.2 *Measured performance of pump*

Every pump shall be demonstrated, by means of one of the methods specified below, to provide on test any flow (up to and including 110 % of the highest design flow) at not less than 95 % of the pressure available on the manufacturer's curve at that flow. The methods are:

(a) Production of a certificate, duly identified with the pump serial number, of a test conducted in accordance with AS 2417 or other approved equivalent;

(b) A bench test conducted in accordance with AS 2417, or other approved equivalent, witnessed by a SSC; or

(c) An *in situ* test of the installed pump unit using a certified test device (whether installed or portable) witnessed by a SSC.

Additionally, every pump forming part of an installed pump unit shall demonstrate on test when the design flow is induced through the alarm valve of every sprinkler installation supplied by the pump unit that:

(d) On newly installed pump units, the available pressure at the alarm valve is at least 105 % of the highest design pressure for that installation; and

(e) Subsequently, that the available pressure at the alarm valve is not at any time less than the highest design pressure for that installation.

NOTE – In evaluating the test results in items (c), (d) and (e), the pressures recorded during flow tests need to be corrected to take account of variance in suction conditions, i.e. tank or town's main minimum permitted suction condition.

607.2.3 *Waterway fittings*

The following requirements apply:

(a) The pump suction and delivery shall be connected to the fixed piping through listed flexible couplings to prevent transmission of running vibration and seismic movement and to ensure that the pump alignment is not stressed by the pipes. Any elastomeric type couplings shall be mechanically restrained;

(b) Stop valves are not permitted between the pump delivery and the main stop valve, unless supervised and the location approved;

(c) Pump suction isolation valves are to be supervised;

(d) Any valves or fittings which are so constructed that turbulence may be introduced through change in direction or obstruction of the waterway shall be located at least 10 nominal diameters of the suction inlet from the entry to the pump. An uninterrupted length of 10 nominal diameters of pipe, the same diameter as the pump suction, shall be installed immediately upstream of the pump suction flange to effect this requirement. See figure 6.9;

(e) When a reducer is required in the pump suction pipework it shall be installed so that no air will be trapped in it, usually necessitating the use of eccentric style reducers. See figure 6.9.

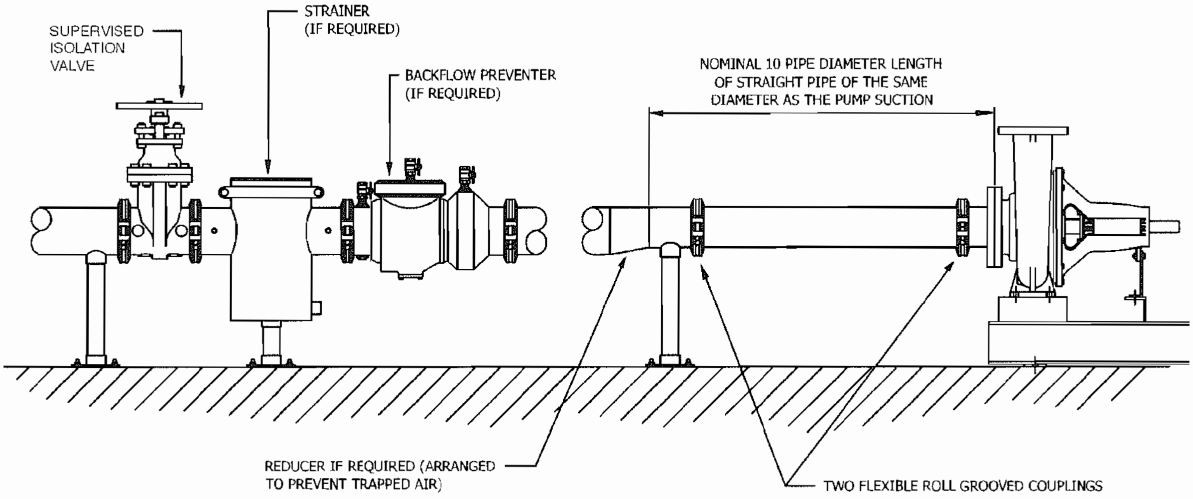

SUPERVISED ISOLATION VALVE
STRAINER (IF REQUIRED)
BACKFLOW PREVENTER (IF REQUIRED)
NOMINAL 10 PIPE DIAMETER LENGTH OF STRAIGHT PIPE OF THE SAME DIAMETER AS THE PUMP SUCTION
REDUCER IF REQUIRED (ARRANGED TO PREVENT TRAPPED AIR)
TWO FLEXIBLE ROLL GROOVED COUPLINGS

Figure 6.9 – Pump suction waterway fittings

607.2.4 *Pump casing cooling*

Means shall be provided to prevent the temperature of the water in the pump casing rising to more than 35 °C during nil or low flow discharge conditions over a 1 hour period. Acceptable means of achieving this include:

(a) A pressure relief valve set to open at a pressure higher than the highest design pressure;

(b) A differential pressure valve;

(c) The diesel motor cooling water supply;

(d) A normally open discharge line to a tank.

Where an around the pump pressure relief and/or test pipe is provided to allow full flow testing, either the foregoing devices or an additional device (manual or automatic) shall be arranged to provide cooling of the pump casing at high flow rates (see figures 6.5 to 6.7) during pump testing. Manual devices shall be labelled.

607.2.5 *Vertical shaft pumps*

Vertical shaft pumps shall be installed to the pump manufacturer's particular specifications and:

(a) Shall be constructed of materials suitable for the quality and acidity of water to be pumped;

(b) Vertical immersion, end suction, radial discharge pumps are not acceptable for installations requiring a shaft longer than 4 m. Where greater depths are involved, a vertical shaft turbine pump shall be used;

(c) Vertical shaft bearings shall be of the water lubricated type and the bearing taking the hydraulic thrust and shaft weight shall be of adequate capacity.

607.2.6 *Submersible electric pumps*

The following requirements apply:

(a) Submersible electric pumps shall be installed to the pump manufacturer's particular specifications;

(b) They shall be constructed of materials suitable for the quality and acidity of water to be pumped;

(c) The motor cable may have only one joint between the controller and the motor and this shall be made in a listed waterproof jointing box;

(d) The insulation resistance and circuit continuity of the motor and circuit from the controller shall be supervised as required by 607.7.6.

607.3 Diesel engines

607.3.1 *Listing of engine*

A listed diesel engine shall be used which shall be of a compression ignition direct injection type and may be naturally aspirated, super- or turbo-charged and/or intercooled. Engine intercooling shall be in accordance with the engine manufacturer's recommendations. Single cylinder engines are not permitted. Only those engines for which spare parts are likely to remain readily available may be listed.

607.3.2 *Power*

The following requirements apply:

(a) The engine shall be able to produce 110 % of the power requirement for the highest design flow when measured against the manufacturer's continuous power rating as defined in Part 1 of BS 5514 or approved equivalent Standard.

The power requirement at the highest design flow shall include an allowance equal to the power absorbed by any supplementary devices driven by the engine and any angled drive.
In the case of a diesel engine driving a boosted town's main pump, "highest design flow" in the preceding paragraph shall mean the higher of:

(i) The highest installation design flow, and

(ii) 110 % of the maximum flow that can be induced in any pressure relief return loop that is provided to limit pump delivery pressure (607.1.10), at the selected setting of the pressure relief valve;

(b) Any ratings or deratings specified by the engine manufacturer shall be observed. In the absence of manufacturer's data the engine shall be derated in kilowatts at the rate of 1.5 % for every 100 m of altitude over 200 m above sea level.

607.3.3 *Performance and commissioning*

The engine shall be able to be started automatically at an engine room temperature of 5 °C and shall accept full load within 30 s of receiving the signal to start. On *in situ* commissioning, the pump unit shall be run for a period of at least 1 hour on increasing load up to duty flow. During this commissioning period at least 10 consecutive starts shall be completed.

607.3.4 *Governing*

The engine shall be provided with a governor to control the engine speed within 10 % of its rated value under all stable conditions of load up to full load rating.

To provide automatic control of excess pump delivery pressure, a listed device may be connected to the governor to automatically reduce the governed speed. Upon any failure of the automatic control, the driver shall resume the unit's maximum specified speed.

607.3.5 *Heating*

Where the pump unit enclosure is not automatically maintained at a temperature above 10 °C, the engine shall be artificially heated by an approved device so as to maintain an engine temperature of at least 25 °C where:

(a) Either the minimum ambient temperature or the minimum engine temperature is maintained by devices dependent upon electrical power, provision shall be made to raise an alarm at an approved place in the event that temperatures drop below the point at which the engine could be relied upon to start;

(b) The temperature sensing and alarm devices shall be listed and shall not depend upon mains electric power. If the alarm device can also be triggered by other supervisory functions, there shall also be a local, labelled, latching indication of the source of the alarm;

(c) A SSC may waive this requirement if ambient temperatures are not expected to drop to this level.

NOTE – See also 607.10.9 and 607.10.10.

607.3.6 *Engine cooling*

The engine shall be cooled by transferring the excess heat, either to air automatically vented to outside the pump house in a manner which complies with 607.3.6.1, or to water from the pump delivery discharged to waste or returned to storage in a manner which complies with 607.3.6.2.

Under full load running conditions, with all doors and windows in their normal positions, the rise in ambient pump room air temperature, measured close to and at the level of the aspirating air intake, shall not exceed 18 °C over a one hour period.

607.3.6.1 *Air cooling*

Where motors are cooled by air the following requirements apply:

(a) Direct

The fan for direct air cooling shall be mounted on the engine crankshaft or be gear or multiple belt driven directly from the crankshaft. The rated capacity of the belts shall not be exceeded if one belt fails;

(b) Indirect

A radiator resiliently mounted in accordance with the motor manufacturer's recommendations, designed for stationary service and with all of the following facilities:

(i) A shaft, gear, or belt driven fan that pushes the cooling air away from the motor

(ii) A shaft, gear, or belt driven coolant circulating pump

(iii) The radiator header tank shall be fitted with the motor manufacturer's overflow/makeup tank and shall have a means of readily checking the level of coolant in it

(iv) The engine manufacturer's coolant circuit shall be used

(v) That the radiator may require to be adequately ducted to control pump enclosure temperatures and/or ensure that adequate fresh cooling air is drawn through the radiator;

(c) Ducting forming part of the air cooling arrangements shall be sized so that the pressure drop across the ducting does not exceed 80 % of the maximum recommended by the manufacturer. Ducts shall discharge to a safe place outside the pump enclosure;

(d) Any louvre forming part of, or required by, the air cooling system shall operate automatically but shall not be dependent on electricity.

607.3.6.2 *Water cooling*

Where motors are cooled by water the following requirements apply:

(a) Cooling water supply, control and discharge:

  (i) Water to cool the engine shall be taken from the pump delivery to two isolation valves

  (ii) One isolation valve shall be strapped open to supply the normal cooling circuit and be labelled "MOTOR COOLING, normally open"

  (iii) The cooling water shall then pass through an easily accessible strainer, labelled "CLEAN MONTHLY". It shall have a screen that can be removed without taking the strainer out of the pipework. The screen shall have holes in it not less than 2 mm or greater than 5 mm in any dimension and the total screen area shall be equivalent to at least 8 times the cross section area of its supply pipe

  (iv) The strainer shall be fitted with a listed device that automatically bypasses it should the strainer become blocked

  (v) A flow regulating device where required shall be fitted downstream of the strainer

  (vi) Where the suction head would cause water to flow through the cooling circuit when the pump is not running, a listed flow control device may be fitted downstream of the strainer

  (vii) The other isolation valve shall enable cooling water to bypass items (iii) and (iv) and shall be strapped shut and labelled "OPEN FOR EMERGENCY COOLING, normally shut". This valve shall discharge into the motor cooling system upstream of the flow indicator

  (viii) The cooling water shall then flow through a listed water flow indicator

  (ix) If the engine requires a coolant circulating pump it shall be shaft, gear or belt driven

  (x) The discharge pipe from the heat exchanger shall be at least one size larger than the inlet pipe. There shall be a flexible connection between the pipework and the engine cooling system or heat exchanger

  (xi) The cooling water assembly shall be of an indirect heat exchanger type;

NOTE – To comply with this item, a listed pump unit manufacturer may obtain a listing for a generic cooling system in which the makes and models of the components are nominated together with pipe sizing, fittings and labelling requirements.

(b) Indirect heat exchangers

  The cooling water assembly may discharge into the secondary circuit of a suitably sized heat exchanger which shall be capable of withstanding the maximum supply pressure that can be applied.

  The primary cooling circuit shall have a header tank with a water volume at least equivalent in capacity to the engine's cooling jacket. It shall be connected to a suitable automatic overflow/makeup tank.

  The header tank shall have a means of readily checking the level of coolant in it;

(c) No part of the engine's waterjacket shall be subjected to a pressure of more than 100 kPa;

(d) All of the above should be agreed to by the engine manufacturer.

607.3.7 *Electric starter motor*

The engine shall be provided with the manufacturer's specified electric starter which shall be nominated in motor listing. The electric starter motor shall be able to crank the engine continuously for 60 seconds followed by one restart, without failure.

607.3.8 *Emergency start device*

In addition to a manually operated starting button, each diesel engine shall have an approved means by which it can be manually started in emergency. One of the following is acceptable:

(a) A manual crank handle provided that sufficient energy can be imparted to the fly wheel to enable it to carry the engine through at least two compression strokes when the decompression lever is released. Any device used to assist manual starting shall return to the automatic start position when released. The entire manual cranking operation shall be capable of being performed by one person;

(b) The electric starter motor used for automatic starting (or an additional listed electric starter motor) provided that it is fitted with an approved device which directly switches both batteries on to the solenoid of the starter motor. The operating lever for this device shall be labelled "EMERGENCY STARTING" with an arrow to indicate the direction of operation and shall be painted green. It shall be spring loaded and strapped in the released position;

(c) Listed inertia and spring driven starters engaging the main ring gear or a separate ring gear. The operating lever shall be painted green and labelled to indicate its function and method of operation. It shall be strapped in the released position.

607.3.9 *Batteries*

Two separate lead-acid starting batteries each capable of supplying the controller load for a period of not less than 24 hours, and thereafter capable of cranking the engine for 60 seconds shall be provided and be indelibly marked "A" and "B" and with the date of installation.

Both batteries shall be normally electrically isolated on their non-earthed side and simultaneously connected to the starter motor only for starting. They shall be located so as to give ease of access for hydrometer testing, be adjacent to, but not over any part of, the pump unit and be protected with a strong non-conductive cover. They shall be secured in accordance with 105.2.

The batteries shall be suitable for continuous operations under float charge conditions, designed for stationery engine starting use, have a minimum service life of 3 years, and comply with AS 2149 or equivalent.

607.3.10 *Combustion air*

The air intake shall be fitted with an adequate filter.

607.3.11 *Exhaust*

Every engine shall have an exhaust which:

(a) Independently discharges to a safe location outside the pump unit enclosure, the outlet so positioned that it is guarded from the entry of rain water and birds;

(b) Is provided with a flexible metallic connection between the exhaust manifold and the exhaust pipe. Where the exhaust pipe rises above the manifold means shall be provided to trap any condensate and prevent it flowing back into the engine;

(c) Is provided with a screwed and plugged manometer hole in the exhaust manifold outlet to facilitate the measurement of manifold pressure. Under full load conditions, the pressure shall not exceed 7.5 kPa except where the manufacturer recommends a lesser maximum pressure;

(d) Has the exhaust pipe adequately supported from the building and kept at least 225 mm from combustible materials. Alternatively, it may be sleeved so that the pipe is at least 50 mm from the sleeve and the sleeve is at least 25 mm from combustibles and with the engine operating at full load, the temperature on the external surface of any exposed combustible material shall not exceed 70 °C;

(e) Is fitted with an adequate silencer, preferably outside the pump unit enclosure;

(f) Has the exhaust pipe guarded wherever it is within 2 m of the floor and could cause injury. Proprietary exhaust pipe wraps shall be permitted to the exhaust pipe only (not manifold, turbo, etc.) provided it is installed in accordance with the engine and the product manufacturers' instructions.

607.3.12 *Drip tray*

A drip-tray of lateral dimensions larger than the engine sump shall be provided under the engine.

607.4 Diesel engine controllers

607.4.1 *Component parts*

A diesel engine controller shall be a listed device consisting of a cabinet housing or supporting instruments, a controller logic unit, battery chargers, listed start pressure switches, manually operated start switch, test logbook, nameplate and such manual controls and technical data sheets as are specified. The electrical connection between the controller and the engine shall be made with a mechanically restrained multicontact plug and socket and the entire controller shall be listed. Removal of the plug from the socket shall cause an indication at an approved location. Where the indication is made at a location which is not staffed at all times, a defect signal shall be generated through the fire brigade alarm (FBA).

607.4.2 *Location*

The controller shall be located in the pump unit enclosure close to, but physically separate from, the engine and pump. It shall be free from engine vibration. Attention is drawn to the need to comply with NZS 1170.5 with respect to restraint against seismic forces.

607.4.3 *Cabinet*

The cabinet shall be robustly constructed and provided with adequate ventilation to facilitate dissipation of heat generated by electrical equipment. It shall include a dustproof compartment for the storage of technical data sheets and the test logbook.

607.4.4 *Instruments, manual controls, alarms and lamps*

The information in the following table shall be displayed in an easily seen and read form on the face of the controller. Analogue displays shall indicate the acceptable duty range by green shading and unacceptable levels by red shading. Tachometers should be digital, with the minimum number of display digits as specified below, or an analogue tachometer of suitable scale.

The controller shall have instruments, manual controls, alarms and lamps which shall enable the operator to determine information relating to the pumpset in an easily recognised manner as set out below:

(a) Digital displays shall have digits at least 15 mm high and comply with the requirements of the following table.

Information	Min. no. of significant figures on digital displays
Pump suction pressure	3
Pump delivery pressure	3
Pump rotational speed	4
Engine run time (hourmeter)	5
Engine lubricant pressure	3
Engine block temperature °C	3
Voltage of each battery	4
Charging current to each battery	3

Optionally, a single digital display may be used to annunciate:

(i) The voltage and charging current for each battery

(ii) The engine lubricant pressure and engine block temperature provided the display automatically defaults to annunciate any parameter in an alarm condition;

(b) The following manually operated devices shall be provided in easily visible positions on the face of the controller:

(i) A manual start button

(ii) A push button device or devices to permit the isolation of each start pressure switch;

(c) The following lamps or LED indicators shall be provided in easily visible positions on the controller to indicate:

(i) Whether each battery charger is energised

(ii) Operation of pressure switch

(iii) The controller unit status

(iv) Closed or isolated state of each pressure start switch

(v) The start logic controller status;

(d) All instruments, controls and lamps shall be clearly labelled as to their function. Where duplicate instruments associated with batteries are provided they shall be labelled either “A” or “B”;

(e) Where remote annunciation is provided for off-normal conditions, for example:

(i) Pump running

(ii) Battery charger off

(iii) High engine temperature

(iv) Engine heating failure

(v) Low engine oil pressure

an alarm unit shall be provided and mounted on the controller to assemble and transmit such signals either individually or collectively. A timing device may be incorporated to suppress such alarms for a period of 60 minutes provided that it will automatically reset.

607.4.5 *Controller logic unit*

The following requirements apply:

(a) A controller logic unit to control the automatic starting sequences of the pump unit shall be provided. Continuity of service and availability of spare parts for the unit shall be considered;

(b) The controller logic unit’s functions shall comply with figure 6.10 and the notes thereto;

(c) Crankshaft speed shall be measured by a sensor driven directly by the crankshaft or a layshaft gear driven from it. The sensor device shall be considered part of the controller logic unit;

(d) If the unit incorporates polarity sensitive devices it shall be protected against or undamaged by reversal of its power supply polarity.

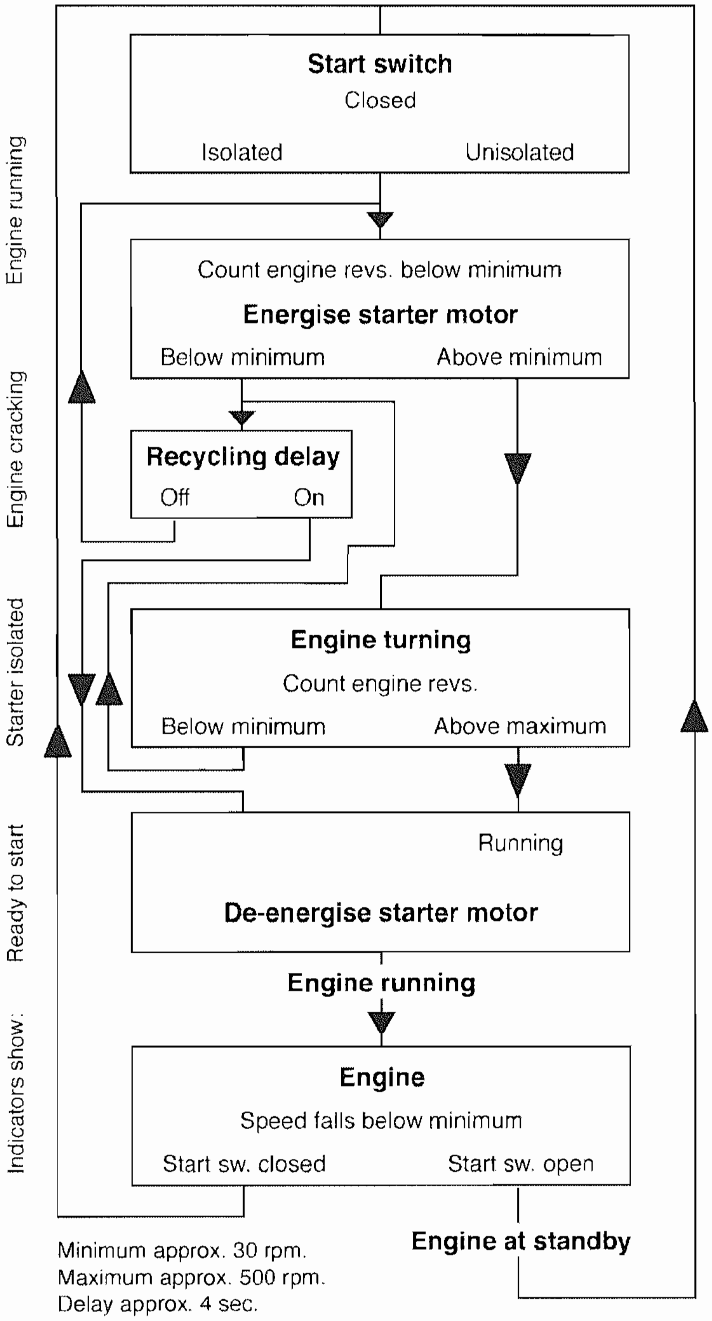


Figure 6.10 – Diesel engine controller logic unit

NOTE –

(1) "Isolated" is a device which individually isolates each start pressure switch that is closed when the isolate button is manually operated. Each pressure switch then remains individually isolated until it reopens.

(2) "30 RPM" and "500 RPM" indicate that the crankshaft is rotating at approximately the stated speed. Actual speeds are to be adjusted in accordance with the engine manufacturer's recommendations.

(3) "Energise" means simultaneously connecting both batteries to the starter motor.

(4) "Ready to Start", "Starter Isolated", "Engine Cranking" and "Engine Running" to be indicated by status lamps or LED indicators.

607.4.6 *Battery chargers*

A listed constant voltage current-limited battery charger shall be provided within the controller cabinet for each of the two starting batteries. The battery chargers shall each:

(a) Have automatic output control that maintains the battery fully charged within the "float" levels specified by the battery manufacturer;

(b) Have automatic control to limit the output current to the maximum rated value of the unit when lead acid batteries discharged to 1.85 V per cell are connected;

(c) Be capable of restoring the full nominal Ampere-hour capacity of the battery within a period of 24 hours while simultaneously supplying the full quiescent current (controller load);

(d) Be capable of tolerating continuous reversed polarity or short circuit on the output terminals without damage, and shall self-restore on removal of the same;

(e) Provide visual indication that the charger is energised.

The charger manufacturer shall specify any design constraints on charger output or the size and length of battery voltage sensing conductors. Compliance shall be required.

The 230 V mains supply for the controller and battery chargers shall be connected to a separate sub-circuit on the building's main distribution board which is clearly labelled "FIRE PUMP BATTERY CHARGERS".

607.4.7 *Start pressure switches*

Listed start pressure switches shall be mounted on the cabinet. They shall comply with 607.1.5. When they close, the initial current shall exceed 0.5 A.

607.4.8 *Nameplate*

An engraved label shall be affixed to the face of the cabinet and give the following information:

(a) Name of pump unit manufacturer;

(b) Unit number;

(c) Duty speed;

(d) Engine make, model and power at duty speed;

(e) Pump make, model and impeller diameter;

(f) Flow and pressure at duty speed.

607.4.9 *Operator's handbook and logbook*

The following shall be kept in the cabinet:

(a) A copy of the electrical circuits associated with the controller logic unit, battery chargers and engine;

(b) Manufacturers' operator handbooks for the pump, controller and engine unit;

(c) An approved logbook for recording all faults and the results of all tests including engine maintenance, oil changes, battery condition, hours run, fuel consumption, annual surveys.

A label showing the name and telephone number of the pump unit maintenance contractor shall be affixed to the inside of the cabinet.

607.5 Diesel engine fuel supply

607.5.1 *General requirements*

Every pump engine shall have its own individual fuel supply tank.

NOTE – Attention is drawn to the need to comply with the relevant requirements of the HSNO Act, specifically those dealing with tank size and attachments, pipes, protection of fuel lines, oil level gauges and fuel secondary containment provisions.

607.5.2 *Tank mounting*

The tank may be mounted inside the pump house, but it shall be mounted separately from the engine with the fuel outlet not lower than the injector pump or more than 1,000 mm above the injector pump, unless this voids the manufacturer's warranty. Tank mounting shall comply with 105.2.

607.5.3 *Tank capacity*

The fuel capacity shall be assessed on the engine manufacturer's specified fuel consumption for the power absorbed by the pump unit at duty rpm for the periods nominated in table 6.2.

Table 6.2 – Nominal fuel duration

Hazard class	Fuel duration (minimum)
Extra light hazard	6 hours
Ordinary hazard	6 hours
Extra high hazard	6 hours but not less than twice the primary supply duration required by table 6.1

607.5.4 *Fuel gauge*

The tank shall be fitted with a listed gauge. The gauge shall be marked indicating that the top half of the tank is fuel for test running and the bottom half is for fire duty running. It shall also indicate that the fuel level shall not normally fall below that allowed for testing.

607.5.5 *Tank construction*

The tank shall be constructed of at least 1.5 mm mild steel coated internally with a suitable anti-corrosive and oil resisting coating after it has been tested for leaks or alternatively of at least 1.25 mm stainless steel.

607.5.6 *Tank connections*

The following connections, none of which shall be galvanised pipe, shall be provided:

(a) A 25 mm vent pipe from the top of the tank that has a continuous upward grade to a down-turned flared and gauze-sealed vent outside the pump house;

(b) A minimum 20 mm filling pipe into the top of the tank. The tank may be filled only by pumping from a mobile tanker, storage tank or a portable drum. A minimum 20 mm filling pipe fixed into the top of the tank for use by a mobile tanker may be supplied, provided that this fill pipe shall extend to the outside of the building, or other suitable location and have a suitable threaded and sized locked valve attached at the delivery end. Suitable precations shall be taken to ensure that if the tank is overfilled, by a mobile tanker, that diesel is not discharged into the pump house;

(c) A 25 mm overflow pipe from the top of the tank which shall be carried on a continuous downward gradient to discharge in a safe place – usually the storage tank or a portable drum;

(d) A sludge sump at the lowest part of the tank, fitted with a normally closed and plugged stopcock;

(e) A sealed opening not less than 100 mm diameter for tank cleaning purposes;

(f) A minimum of a 10 mm fuel outlet drawing from at least 25 mm above the bottom of the sludge sump and fitted with a stop valve padlocked in the open position;

(g) A fuel return line sized and installed in accordance with the engine manufacturer's recommendations.

607.5.7 *Fuel secondary containment*

Where required by the HSNO Act, provisions shall be made for diesel fuel secondary containment. One such method is to install the diesel fuel tank in a bunded area.

607.5.8 *Fuel lines*

The fuel lines shall be at least 10 mm seamless copper or stainless steel tube with double ferrule compression fittings, brazed joints or black steel pipes and fittings and shall:

(a) Be well protected and supported, preferably in a continuous down-gradient to the engine. However, it is permissible to have one low point, provided there is a continuous rise from this point to both the engine and the fuel tank;

(b) Incorporate a transparent agglomerator bowl, immediately downstream of the fuel line stop valve, to indicate the presence of water, and an accessible, engine mounted, filter;

(c) Terminate at the engine at a metal armoured flexible connection.

NOTE – This clause does not apply to any fuel lines forming part of the engine manufacturer's Original Equipment Manufacturer (OEM) equipment.

607.5.9 *Air lock avoidance*

Care shall be taken to avoid air locks in the system. No air relief valves are permitted and where air relief is essential, screwed plugs shall be used.

607.6 Electric motors

607.6.1 *Type*

Electric motors shall be of the three-phase low voltage squirrel cage drip-proof or totally enclosed type.

607.6.2 *Power*

The following requirements apply:

(a) The motor shall have 110 % of the capacity required to ensure that the continuous rated current is not exceeded under any conditions of pump discharge when power is being supplied at the nominal voltage. Should the motor have a service factor of 10 % or greater, this requirement shall be deemed to have been met;

NOTE –

(1) This 10 % capacity margin is necessary to take account of fluctuations in the supply voltage that will increase the current.

(2) Attention is drawn to the need to check the actual pumpset turning speed to ensure that the motor can provide the power absorbed by the pump at that speed.

(b) The locked rotor current shall not exceed 750 % of the full load current of the motor.

607.6.3 *Nameplate*

The motor shall have a nameplate attached to it, on which is indelibly marked:

(a) Manufacturer's name;

(b) Type and serial number;

(c) Continuous rated power output;

(d) Working voltage and frequency;

(e) Rotational speed at full load;

(f) Full load current.

607.6.4 *Height above floor*

Other than with submersible pumps, the pump unit shall be so mounted that no current carrying part of the motor is less than 150 mm above the floor.

607.6.5 *Vertical shaft motors*

Motors driving vertical shaft pumps shall be constructed for vertical operation and, if driving an assembly longer than 4 m, shall have a hollow shaft. Alternatively, the motor shall be of a listed submersible type.

607.6.6 *Motor starting*

The motor shall be started and stopped by means of a listed electric motor controller.

607.7 Electric motor controllers

607.7.1 *Component parts and listing*

An electric motor controller shall be a listed device the component parts of which are:

(a) A cabinet supporting or enclosing items (b) to (j);

(b) A listed start pressure switch or switches and associated test devices;

(c) Pressure switch isolation devices;

(d) Manual start and stop buttons;

(e) Start contactor;

(f) Power supply supervisory equipment;

(g) Overload protection supervisory equipment;

(h) Pump running alarm switching devices;

(i) For submersible pumps insulation resistance and circuit continuity supervisory equipment;

(j) A nameplate showing the following information:

  (i) Name of manufacturer
  (ii) Unit number
  (iii) Pump make, model, turning speed and impeller diameter
  (iv) Duty flow and pressure.

607.7.2 *Location*

The controller shall be located in the pump unit enclosure as close as practicable to the motor with all electrical components at least 450 mm above the floor.

607.7.3 *Starting and stopping*

Automatic starting shall be provided by means of listed pressure switches and manual starting shall also be provided.

Stopping and isolation devices shall comply with 607.1.7. Additionally there shall be a lockable ON/OFF switch to isolate the power supply to the contactor.

607.7.4 *Start contactor*

The following requirements apply:

(a) The motor starting method shall be by a direct on line electromechanical contactor, except where the power supply is insufficient to allow direct on line starting, then either of the following may be used:

    (i) An approved electronic variable power soft starter, or

    (ii) An approved electronic variable frequency starter and speed controller, provided it is arranged to fail into direct on line frequency and voltage mode;

(b) The current rating of the contactor shall be at least 125 % of the nameplate continuous current rating of the motor;

(c) The short circuit category of duty shall be AC-3 to IEC 60947-4.

607.7.5 *Overload protection*

The following requirements apply:

(a) The thermal overloads shall be arranged to reset automatically. They shall be capable of adjustment to carry 30 % more than the nameplate continuous current rating of the motor;

(b) An adequate setting may be demonstrated by five successive pump starts at 20 s intervals without tripping, with the pump test return valve part open;

(c) They shall be supervised in such a way as to comply with 607.7.6;

(d) Motor winding temperature sensors, if fitted, may be used to operate a motor overheat alarm but they shall not automatically trip the motor contactor.

607.7.6 *Supervisory monitoring*

The following requirements apply:

(a) Approved supervisory monitoring of all of the following conditions shall be provided:

    (i) Pump running

    (ii) Loss or reversal of any phase at the line terminal of the contactor

    (iii) Opening of any section of the contactor control circuit except the start button

    (iv) In submersible motor driven pumps, low insulation resistance and discontinuity in the motor circuit;

(b) Except in the case of (a)(i), the absence of the above conditions (that is, normal state) shall be indicated on the face of the motor controller by means of continuous visual indicators;

(c) The detection of any of the conditions specified in (a) above shall, after approximately 120 min, cause two sets of clean changeover contacts to switch. A test device shall be incorporated to compress the gating time to approximately 12 s;

(d) A listed alarm device, located in an approved location external to the pump unit enclosure, shall be connected to the supervisory device. The alarm shall be labelled "SPRINKLER FIRE PUMP MALFUNCTION ALARM", followed by instructions on who to contact.

607.8 Power supply

607.8.1 *Source*

The following requirements apply:

(a) The power supply shall be obtained from an electrically reliable and physically secure source, preferably from a public supply by an exclusive separate connection;
(b) Where a suitable public supply is not available, approval of the generating plant shall be obtained;
(c) Where a separate connection from the public supply is not provided, a separate circuit shall be taken from a point on the line side of a switch by which all other electrical services in the premises can be isolated to directly and exclusively supply the pump motor, motor starter and other ancillary services in the pump room;
(d) Conductors shall be appropriately sized to meet the motor manufacturer's requirements for nameplate voltage.

607.8.2 *Security*

The following requirements apply:

(a) No part of either the high voltage or low voltage circuit inside the boundary of the protected premises shall pass through an unprotected building. Exterior overhead cables inside the protected premises shall not pass closer than 10 m (measured horizontally) to any unprotected building or unprotected fire loads;
(b) There shall not be any switches on the circuit supplying the pump between the isolator on the pump unit controller and the point at which it is connected to the main supply;
(c) All switches on the protected premises which are capable of isolating the pump shall be clearly labelled "SPRINKLER FIRE PUMP – LEAVE ON" in white letters on a red background;
(d) The normally open circuit wiring between the pump contactor and the motor shall be protected against physical damage. In the case of submersible pumps, this part of the circuit shall comply with 607.2.6 (c).

607.9 Facilities for routine testing

607.9.1 *General*

Every pump unit shall have facilities to allow routine test running under load and to prevent overheating in situations of nil or low discharge (see figures 6.5 to 6.8).

607.9.2 *Open water source*

Where a pumping unit draws directly from a tank or open water supply a test return pipe shall be provided and sized to enable the unit to be tested to a minimum of 110 % of the highest design flow (± 10 %). For pumps fitted with pressure relief valves complying with 404.6.4, test return pipework and valving may not be required if the pressure relief valve circuit produces at least 110 % of the highest design flow (± 10 %).

In the case of tank supplies the test return pipe shall terminate at least one metre below normal water level to prevent air entrainment during testing and shall be restrained against jet reaction. If the same pipe is used for the pressure relief valve discharge then it must be terminated at vortex plate level.

The test return pipe shall be fitted with a supervised, labelled, indicating stop valve normally padlocked in the closed position. This valve shall signal “defect” when opened greater than 5 %.

607.9.3 *Boosted town’s main*

A test return loop from the pump delivery to the pump suction shall be provided and sized to enable the unit to be routinely test run at least 110 % of the highest design flow (± 10 %). For pumps fitted with pressure relief valves complying with 404.6.4, test return pipework and valving may not be required if the pressure relief valve circuit produces at least 110 % of the highest design flow (± 10 %).

This test return loop shall be fitted with a supervised, labelled, indicating stop valve normally padlocked in the closed position. This valve shall signal ‘defect’ when opened greater than 5 %.

607.10 Pump unit enclosure

607.10.1 *General*

All pump units shall be installed in a clean dry weathertight enclosure with secure access to the sprinkler apparatus.

It is recommended that the pump unit enclosure is provided with direct external access.

607.10.2 *Protection from hazards*

The enclosure shall be situated where it is as free as possible from exposure to fire, explosion, flooding and windstorm damage and, in the case of below ground enclosures, care shall be taken to avoid or deflect run-off storm water from draining into it.

No liquid or gaseous fuels except those required as a fuel source for the pump unit prime mover shall be reticulated or stored in the enclosure and a fire extinguisher appropriate to the hazard shall be provided.

607.10.3 *Plant rooms*

With approval, a pump unit may be located in a screened area of a plant room protected by the sprinkler system complying with this Standard. In considering any such application, a SSC shall ensure that there is:

(a) No boiler or other explosion hazard;

(b) No uncontrolled dust problem;

(c) No likelihood of water from other services discharging over the pump unit;

(d) No uncontrolled access by unauthorised persons to the pump unit.

All other requirements for pump unit enclosures shall be met.

607.10.4 *Sprinkler protection*

All pump unit enclosures shall be sprinkler protected. Where the enclosure is a detached building and is some distance from the nearest protected building, the sprinklers in the enclosure may be supplied through a labelled and strapped stop valve from the hydraulic connection to the start pressure switches, provided that this has been suitably sized, or a connection is provided from the pump delivery, through a check valve, to a point downstream of the stop valve to boost the supply to the pump house sprinklers. Acceptable arrangements to sound an alarm if such sprinklers operate shall be provided.

607.10.5 *Enclosure size*

The enclosure shall be of sufficient size to allow free access for testing, maintenance and removal of all equipment therein.

607.10.6 *Access*

Access shall be by a lockable door or hatch sufficiently large and located in such a position as to allow the removal of any individual component of the pump unit without disturbance or damage to other components.

607.10.7 *Drainage*

The floor shall be graded to drain to a sump which shall be emptied by means of a gravity drain or an automatic sump pump at a flow of at least 50 L/min. The sump shall be at least 600 mm deep and shall have a capacity of at least 0.05 m^3.

607.10.8 *Lighting*

The enclosure shall be provided with artificial lighting.

607.10.9 *Ventilation*

There shall be sufficient ventilation to prevent condensation, to provide aspiration for any diesel engines and to limit the temperature rise to 18 °C above ambient under all conditions of pump load for a one-hour period.

Ventilation and/or louvres shall not be dependent on mains electrical power supply.

Powered ventilation systems utilising the diesel engine shall be permitted. The requirements of 607.3.2 shall be complied with.

607.10.10 *Heating*

The enclosure shall be provided with a maximum/minimum type thermometer permanently fixed not more than 1.5 m from the floor. A reliable source of artificial heating shall be provided where necessary so as to maintain the temperature in the enclosure above 5 °C at all times.

NOTE – In the case of diesel engines, heating of the engine may also be necessary.

608 ELEVATED TANKS

An elevated tank shall:

(a) Comply with 606.2 and 606.3;

(b) Be owned by, and under the sole control of, the owner of the sprinkler system or shall, in terms of suitable written guarantees, be available at all times for the use by the owner of the sprinkler system;

(c) Be of sufficient capacity to comply with 606.1;

(d) Be of sufficient height above the alarm valves to furnish without the use of pumps the requisite pressures at the design flows specified by 603.

609 PRESSURE TANKS

Pressure tanks shall be accepted in the case of extra light hazard class only subject to the approval of a SSC.

610 FIRE SPRINKLER INLETS

610.1 Function

All automatic sprinkler systems shall be fitted with a fire sprinkler inlet connection to:

(a) Enable the fire brigade to pump water into the installation by the use of their own equipment during a fire;

(b) Permit proving tests of the water supplies to the installation to be regularly carried out;

(c) Facilitate the connection of an emergency water supply to the sprinkler installation if the usual supplies have been disabled.

610.2 Location

Fire sprinkler inlets shall be on the outside of the protected premises in a location approved by the New Zealand Fire Service so as to permit effective fulfilment of each function. The fire sprinkler inlets may be located remote from the building provided that all criteria of the Standard are met.

NOTE – The New Zealand Fire Service is preparing "A guide to Fire Service operations in buildings" which provides guidance on their general requirements for the location of fire sprinker Inlets.

610.3 Enclosure

610.3.1 *Construction*

The following requirements shall be met:

(a) Fire sprinkler inlets shall be housed in enclosures constructed to ensure that delivery hoses can be connected to the couplings without kinking. The enclosure shall be of such dimensions to allow a solid cone having an included angle of 45° to be placed in each connection coaxially with the connection, without the cone touching any part of the enclosure or open door. No part of the enclosure or the door when open shall be a lesser distance than 125 mm from the axis of any connection projected. Couplings shall be located no more than 150 mm from the internal face of the enclosure door.

The axis of the couplings shall be between 15° and 30° down from the horizontal. See figure 6.11;

(b) A clearance of at least 75 mm shall be provided between the rim of any hand-wheel and any part of the enclosure or equipment;

(c) This enclosure may be deleted where sprinkler valve enclosures open to the exterior of the building through double doors with a total open width of at least 1.5 m. The fire sprinkler inlet shall be located on one side of the door opening. Where there are water supply pump sets in the enclosure the fire sprinkler inlet assembly shall be fitted with a splash guard as per 610.3.3;

(d) This enclosure may be deleted where valve sets are installed within self-contained cabinets designed for mounting on the exterior face of the building.

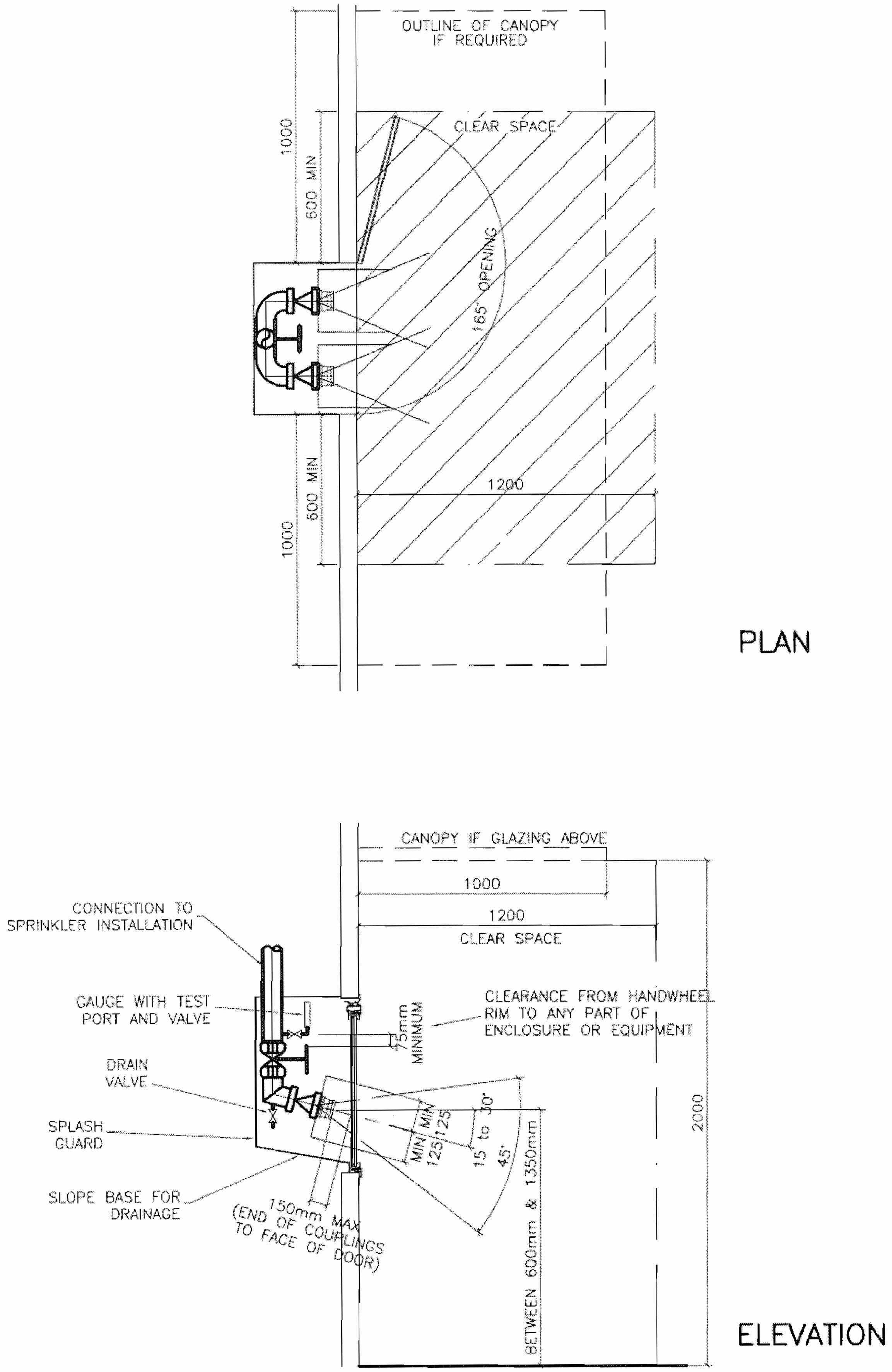
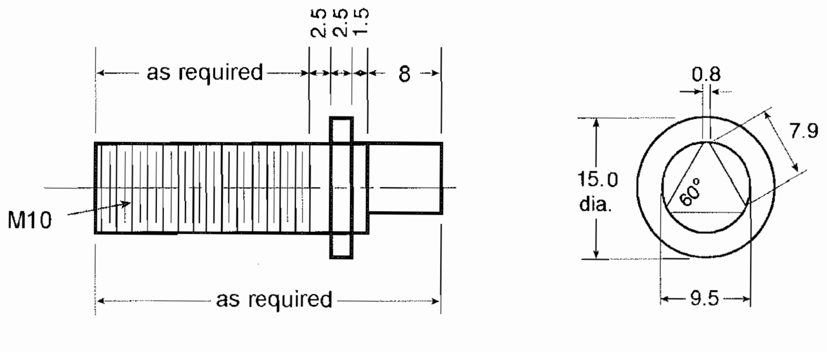


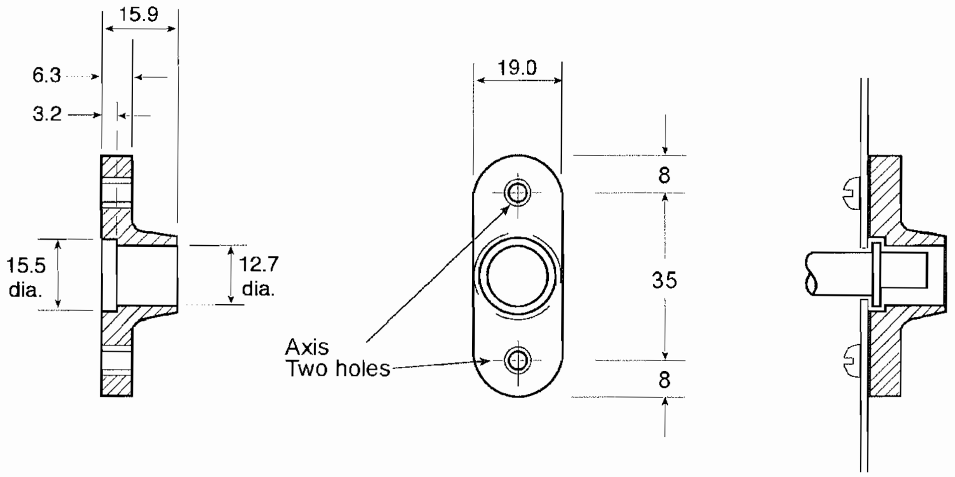
Figure 6.11 – FSI standard requirements

610.3.2 *Door*

Doors may be side hung or bottom hung and shall in either case, open through not less than 165°. The door shall be locked by a triangular key locking device, as shown in figure 6.12, requiring no more than 5 revolutions to open the lock.



SCREW



BASE

Dimensions in millimetres

Figure 6.12 – Details of box lock

The door shall have a break-out panel large enough to enable delivery hoses to be connected without kinking, if the door cannot be opened and emergency access has to be made by breaking out the panel.

The break out panel should be designed so that on removal no sharp edges shall remain.

The outside of the enclosure door shall bear the words "FIRE SPRINKLER INLET" in contrasting letters of at least 50 mm high.

The inside of the enclosure shall have an engraved label bearing the words "FIRE BRIGADE! BOOST PRESSURE IF GAUGE IN RED SECTOR". In the case of enclosures housing more than one stop valve the words "FIRE BRIGADE! BOOST PRESSURE ON ANY INSTALLATION WITH GAUGE IN RED SECTOR" shall be used. The sign shall be collocated to the gauge specified in 610.5.3.

610.3.3 *Splash guards*

With the exception of fire sprinkler inlets installed in compliance with 610.3.1(c) & (d), a splash guard shall be provided to the sides, rear and bottom of the enclosure to ensure that the risk of water damage to the interior of the building is minimised. The splash guard shall be provided with suitable drainage.

610.3.4 *Usage*

The enclosure may also be used to house the fire sprinkler inlet for any fire hydrant system serving the building. In such cases, the fire hydrant system and the fire sprinkler inlet shall be separate assemblies, each bearing the words "FIRE SPRINKLER INLET" and "FIRE HYDRANT INLET" in contrasting letters of at least 50 mm high respectively.

Other than any indication and control panels for the control of fire hydrant systems, the enclosure shall not be used to house any other equipment.

610.4 Inlets

610.4.1 *Specification*

Each inlet shall consist of a 70 mm male instantaneous hose connection and shall comply with SNZ PAS 4505. It shall be fitted with a clapper valve of the swing-hinged type.

610.4.2 *Number of inlets*

The number of inlets shall be provided in accordance with table 6.3.

Table 6.3 – Number of inlets

Highest system design flow (L/min)	**Minimum number of inlets required**
Up to 1350	1
Up to 2700	2
Up to 4050	3
Up to 5400	4
Up to 6750	5
Greater than 6750	6

610.4.3 *Height of couplings*

The fire sprinkler inlet shall be positioned so that the axis of the highest and lowest coupling is not closer to the surrounding standing surface than 600 mm or further than 1,350 mm.

610.4.4 *Clear working space*

A space measuring 600 mm either side of the inlet enclosure, 1,200 mm out from the face of the enclosure and extending up 2,000 mm from the surrounding standing surface shall be clear of all objects.

610.4.5 *Falling glass*

Where the door of the enclosure is on a glazed exterior wall of a multi-storey building, either a veranda or other assembly shall be provided extending at least 1 m in front and 1 m either side of the enclosure to provide protection from falling glass.

610.5 Connection pipe to system

610.5.1 *Point of connection*

The following requirements apply:

(a) The inlets shall be connected by pipework through a stop valve directly into the installation downstream of the alarm valve and main stop valve, and in enhanced safety valve sets downstream of the subsidiary stop valve;

(b) Where there is more than one alarm valve, they may all be connected through check valves and a manifold to the same inlet provided that a normally open, locked, supervised isolation valve is fitted to each connection. The isolation valve shall signal "Fire" when closed for more than two turns or 5 %;

(c) Where there is more than one alarm valve, and the provisions of (b) are incorporated into the fire sprinkler inlet design, a normally locked and closed test valve shall be installed to bypass the manifold check valve for the system with the highest design flow. Where multiple alarm valves are not collocated at one valve house a bypass test valve shall be located at each valve house;

(d) Where there is more than one alarm valve and the provisions of (b) are incorporated into the fire service inlet design, install a fire service inlet check valve test valve (normally locked close) to allow the check valves to be exercised in accordance with 1202.4(g);

(e) In wet pipe and antifreeze systems, the pipework downstream of the manifold check valves shall be primed from the water supply by a 15 mm nominal bore connection via a locked open isolation valve. See figure 6.13;

(f) Where a second stop valve is installed downstream of the alarm valve (as in a dry pipe valve situation), the fire sprinkler inlet connection shall be connected upstream of such a stop valve, to permit flow testing;

(g) The pipework and manifold(s) shall comply with the requirements of 109.

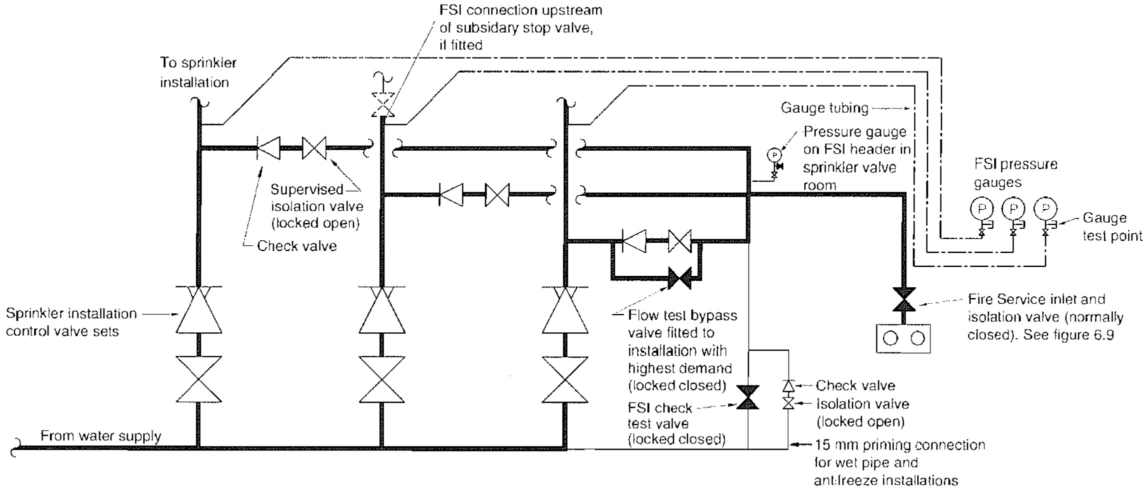

FSI connection upstream of subsidary stop valve, if fitted
To sprinkler installation
Gauge tubing
Pressure gauge on FSI header in sprinkler valve room
FSI pressure gauges
Gauge test point
Supervised isolation valve (locked open)
Check valve
Sprinkler installation control valve sets
Fire Service inlet and isolation valve (normally closed). See figure 6.9
Flow test bypass valve fitted to installation with highest demand (locked closed)
FSI check test valve (locked closed)
Check valve
Isolation valve (locked open)
From water supply
15 mm priming connection for wet pipe and antifreeze installations

Figure 6.13 – Fire service inlet arrangement for multiple valve sets

610.5.2 *Stop valves*

Stop valves shall be suited to the duty pressure, be slow closing, provide a drip tight seal and not incorporate metal to metal seating. The valve shall be housed in the cabinet. A metal or plastic label bearing the words "OPEN BEFORE PUMPING" shall be fitted to the hand-wheel, or collocated directly adjacent.

Where there is more than one stop valve, each valve shall be numbered in contrasting numerals at least 40 mm high according to the installation which it controls.

610.5.3 *Pressure gauges*

A pressure gauge shall be fitted in the cabinet, connected to the installation side of each stop valve and shall be marked with a red sector between zero pressure and a pressure 100 kPa above the highest design pressure requirement for that particular installation. The remainder of the scale shall be shaded green. Where there is more than one pressure gauge, it shall be labelled with the number of the installation to which it is connected. Where the direct access to the fire sprinkler inlet is via the valve house doors, it shall be permissible, in a single installation system, to comply with this requirement by shading the installation gauge.

610.5.4 *Pipe size*

The size of the connecting pipework and stop valve shall be such that at the highest design flow, the pressure loss due to friction between the inlet coupling and the alarm valve does not exceed 100 kPa. In the case of any secondary fire sprinkler inlets installed on the installation, connecting pipework to the system shall be such that at the highest design flow, the pressure loss due to friction between the secondary FSI and the most hydraulically remote area of operation, plus the design point pressure, does not exceed P_{NC} (refer to NZS 4510).

610.5.5 *Pipework bracing*

The fire sprinkler inlet valves and pipework (including any permanent test outlet) shall be braced to withstand the forces developed during flow testing of sprinkler system water supplies.

610.5.6 *Duty pressures exceeding 10.5 bar*

If, in the event of failure of the sprinkler system water supply, the maximum required boost pressure at the fire sprinkler inlet exceeds 10.5 bar then special provisions in the fire sprinkler inlet design shall be provided. These special provisions shall be approved by a SSC.

Such special provisions may include the provision of a valved connection which would allow the building's wet riser diesel driven pumpset (designed and installed in accordance with NZS 4510) to boost the sprinkler system fire sprinkler inlet pipework. In such cases, the valve shall be operable from the sprinkler system fire sprinkler inlet cabinet and its purpose clearly and indelibly marked in letters at least 50 mm high.

NOTE – It is not acceptable to connect the sprinkler system fire sprinkler inlet to the suction side of the sprinkler system pumps, as this does not cater for any event where the sprinkler system water supply has failed. In such cases, it is expected that the sprinkler system pumps may have seized, prior to the Fire Service providing water to them.

610.5.7 *Permanent test outlet*

For design flows exceeding 3,500 L/min a permanent test outlet shall be connected between the fire sprinkler inlet stop valve(s) and the inlet clapper valve(s) to allow the connection of large flow testing devices. The test connection shall consist of either a 100 mm flanged or rolled groove fitting with, under normal conditions, a blank flange or cap. For design flows in excess of 9,000 L/min, two independently valved test connections shall be provided. The outlet shall be located within, or immediately adjacent to, the cabinet and so sited as to allow free discharge of 125 % of the design flow without causing damage to property.

611 PROVING OF WATER SUPPLIES

611.1

To facilitate tests to verify that the water supply satisfies the pressure/flow requirements appropriate to the installation, provision for connection of a portable flow measuring device to the fire sprinkler inlet or permanent test outlet, as applicable, shall be provided.

611.2

Where a number of installation control valves are sited together and all are associated with installations of the same hazard class, this testing facility is necessary only on one installation control valve, provided that it is fitted to the valve which is hydraulically the least favourably situated.

611.3

Where more than one hazard class is involved, whether on the same or separate installation control valves, testing facilities shall be provided to enable the full range of flows to be measured. This requirement may be waived by a SSC where it is obvious, from testing of the higher flow rate, that the lower pressure/flow requirements are satisfied.

612 PRIVATE SITE FIRE MAINS

(see 602.1 Class B2)

612.1 Piping

612.1.1

Pipework may be reticulated throughout the site through a combination of buried or above ground pipework. Where pipe is above ground, it shall be located to minimise the potential that it may be damaged, by natural events, or by explosions, vehicle accidents and the like.

612.1.2

Buried pipework shall be provided with thrust restraint in accordance with best trade practice and with allowance for anticipated vehicle movements.

612.1.3

Pipework above ground shall be installed on suitably constructed pipe supports or pipe bridges designed to AS/NZS 1170 series as applicable.

612.1.4

Piping shall be sized by hydraulic calculation to allow for the isolation and/or, repair of any section of the fire main, or the impairment of either of the water supplies, and still provide the design flow and pressure.

612.2 Valves

All valves shall comply with 602.1, 602.4 and 604.1.8.1(d).

612.3 Water supply

Each water supply to the fire main shall conform to this Standard except that:

(a) Where the ring main forms part of a dual supply (602.1), pumps may be started by detection of pressure drop in the fire main, providing the normal means of pressurisation can be maintained for a minimum period of 24 hours without reliance on the standard power supply (see also 607.1.5.2);

(b) The continuous rating of diesel engines forming part of a water supply shall provide the power requirements of the pump under any condition of pump discharge.

NOTE – Details of how the ring main will be pressurised must be supplied to a SSC as part of the information required within the basic design decision submission (see 112.1(s)).

612.4 Other

612.4.1

Details of the site fire main shall be incorporated on a block plan in every fire pump enclosure supplying the fire main.

612.4.2

The flow and pressure characteristics of each connection to the private site fire main shall be determined by applying the requirements of Appendix C2 as if the site fire main was a town's main.

Part 7
EXTRA LIGHT HAZARD SYSTEM DESIGN DATA

701 WATER SUPPLIES

701.1 Design criteria

Extra light hazard (ELH) systems shall be designed to meet one of (a) to (c):

(a) To allow the hydraulically most remote six heads to provide a flow of at least 57 L/min from each sprinkler regardless of the area covered by an individual sprinkler;

(b) In areas where residential sprinklers are fitted, to provide for the four most hydraulically demanding sprinklers; or

(c) In areas where extended coverage light hazard (ECLH) sprinklers are fitted, to include an assumed area of operation of five sprinklers, but not less than 140 m^2, discharging in accordance with the listing for the sprinkler head.

In (a) above, the hydraulically most remote group of sprinklers shall be selected to form as near as possible a square with the longest side positioned so that it imposes the greatest hydraulic demand. Except as varied by this clause, hydraulic calculation methods shall conform to the requirements of Part 10. Sprinklers in cupboards and wardrobes need not be included in the calculation.

In (b) above, the minimum discharge from each sprinkler is to be the greater of the following: the listed flow rates for ANSI/NFPA 13D and ANSI/NFPA 13R systems; or a minimum discharge density of 4.1 mm/min over a design area of the four most hydraulically demanding sprinklers for the actual coverage areas for the sprinklers.

NOTE – Users of this Standard should be aware that the use of outdated data sheets may not provide the latest listing data called up for residential heads. Attention is also drawn to the need to apply the most onerous of the two design criteria provided above.

In (c) above, interpolation of criteria between listed spacings shall not be used. The minimum discharge density shall be 4.1 mm/min.

701.2 Water supplies

701.2.1

Each water supply shall be capable of providing at the installation control valves, the design flow at the design pressure. The design pressure for systems having any sections fitted with residential sprinklers shall not be less than the pressure required to operate any single residential sprinkler at its appropriate listed flow and pressure.

701.2.2

Pipe sizes shall be determined by full hydraulic calculation in accordance with Part 10.

701.2.3

Where external sprinklers impose a demand greater than that of the protected area the values of the design flow and design pressure shall be increased accordingly.

701.3 Extensions to existing systems

701.3.1

Existing systems, installed in accordance with superseded editions of this Standard, may be extended by a maximum of 4 sprinklers with pipe sizes in accordance with the method set out in 703. Where the array pipework beyond the design points is sized to table 7.1, the design flow shall be 270 L/min and the design pressure 190 kPa plus whichever is the greater of 90 kPa or the pressure equal to the distribution pipe losses between the control valves and the hydraulically most remote design point, plus the pressure equivalent of the difference in height between the valves and the highest sprinkler. In such cases, only 10 mm sprinklers may be used.

701.3.2

Where the ranges in an area of operation are connected to a section of looped distribution pipe, the design point is the hydraulic mid-point of that section of distribution pipe.

701.3.3

Design points are those points on the pipework at an equivalent hydraulic length not greater than 7 m upstream from the fourth sprinkler on any range under consideration, or on ranges of less than four heads at the junction of the next upstream range on the distribution pipework.

701.3.4

The designs of hydraulically calculated systems may incorporate any pipe sizes that are permitted by Part 10 and proven to satisfy the design requirements of that Part.

Table 7.1 – Minimum pipe sizes for precalculated extra light hazard sprinkler arrays

	Normal diameter of pipe			
	From last to 2nd head (mm)	**Between 2nd and 3rd head** (mm)	**Between 3rd and 4th head** (mm)	**Between 4th head and design point** (mm)
Option A*	20	25	32*	–
Option B	20	25	40	50
Option C	25	25	32	40
Option D	25	32	32	32

NOTE – Option A* provides for a 3-head range and the 32 mm diameter therefore relates to the pipe between the 3rd head and the design point.

702 SPRINKLER TYPE AND SPACING

702.1 Sprinkler types

702.1.1

In sleeping areas, sprinkler heads shall be residential type or quick response standard spray.

In this context, “sleeping areas” includes bunkrooms, hospital wards, bedrooms, dormitories and individual suites in hotels, motels and apartment buildings. “Individual suites” means that area (whether partitioned or not) to which access is controlled by the room key i.e. bedrooms, bathroom suite, lobby, lounge and kitchen where provided.

Hospital wards containing more than four beds per room shall not be protected with residential sprinklers. Quick response standard spray sprinklers shall be used.

NOTE – To achieve comparable detection some ECLH sprinklers are fitted with a more responsive heat activated element, although fitted with a more responsive element ECLH sprinklers are not necessarily listed as quick response sprinklers.

702.1.2

In all other areas, except as provided for in 702.1.3, either quick response or standard response spray pattern 10 mm or 15 mm sprinkler heads shall be used.

702.1.3

In areas related to sleeping areas, including corridors, lift lobbies, stairways and foyers, and in care institutions, day rooms or lounge areas, residential or quick response or standard response spray pattern sprinklers may be used. Residential sprinklers shall not be used in kitchens, cafeteria, restaurants, bars, storerooms, laundries, plant rooms, ceiling spaces or roof spaces.

702.1.4

Standard response sprinklers may be used in small ancillary spaces, related to sleeping occupancies, such as cupboards, laundries, toilets and bathrooms, where such spaces are protected by one head.

702.2 Coverage

The maximum area coverage per sprinkler shall be:

(a) Sidewall sprinklers ....17 m^2

(b) Extended coverage light hazard sprinklers ....As indicated on the listing.

(c) Other spray sprinklers ....21 m^2

(d) Residential sprinklers ....As indicated on the listing.

702.3 Spacing

702.3.1

The maximum distance between sprinklers on range pipes and between adjacent rows of sprinklers shall be:

(a) Sidewall sprinklers ....See 510.

(b) Extended coverage light hazard sprinklers ....As indicated on the listing.

(c) Other spray sprinklers ....4.6 m

(d) Residential sprinklers ....As indicated on the listing.

702.3.2

The maximum distance between sprinklers and walls or partitions shall be half the distance set out in the above clauses. Where staggered spacing is used see 504.1.

703 PIPEWORK

703.1 Sizing (ELH pipework)

703.1.1

Pipework shall be sized either on the basis of full hydraulic calculations in accordance with Part 10, or, in the case of extensions to existing systems in compliance with 701.3, shall have those pipes downstream of any design point (i.e. the array) sized at least as large as is specified in table 7.1. Where roof or ceiling gradients exceed 1 in 4 and ranges are fed up the slope, full hydraulic calculation shall be used.

703.1.2

Where array pipework is installed in accordance with table 7.1, pipework between the control valves and the design points shall be sized according to hydraulic calculations so as not to exceed the available water supply pressure measured at the design flow. Values for friction losses in pipes at a flow of 270 L/min are as follows:

Pipe diameter (mm)	25	32	40	50	65	80	100
Loss (kPa/m)	29	7.4	3.6	1.1	0.33	0.15	0.04

703.2 Fittings

The loss of pressure at each elbow, bend or tee, where the water is turned through an angle, shall be taken as equal to that of 1.5 m of straight pipe of the smallest diameter pipe of the waterway direction change.

704 STORAGE AREAS AND DRYING ROOMS

704.1

The fire loads in small storage rooms and drying rooms require higher discharge densities than 2.7 mm/min.

Any such rooms, which are separated from other areas by full height partitions or walls and which are of an area that may be protected by up to 6 sprinklers spaced at not more than 12 m^2 when pipework is fully hydraulically calculated, or up to 4 sprinklers when installed in accordance with 701.3 spaced at not more than 12 m^2, shall be protected by 15 mm sprinklers where pipework is sized according to table 7.1. Pipework shall be sized to ensure that the density is not less than 5 mm/min.

704.2

Any storage or drying room larger than the area specified in 704.1, shall be regarded as a separate occupancy and be classified as ordinary hazard group 3 or extra high hazard. See 203.2.5.

Part 8
ORDINARY HAZARD SYSTEM DESIGN DATA

801 DESIGN CRITERIA, PIPE SIZING AND WATER SUPPLIES

801.1 Design criteria

Ordinary hazard systems shall be designed either:

(a) To provide a design density of discharge of at least 5 mm/min over the following assumed area of operation:

(i)	Group I (light ordinary hazard)	Any group of 6 sprinklers operating but not less than 54 m^2
(ii)	Group II (medium ordinary hazard)	Any group of 18 sprinklers but not less than 162 m^2
(iii)	Group III (high ordinary hazard)	Any group of 18 sprinklers but not less than 162 m^2
(iv)	Group III Special	See 801.1(c).

NOTE – Group III Special is an extension of Group III occupancies where flash fires are likely, covering somewhat larger areas of operation, such as preparatory processes in textile mills and certain other risks.

In areas with ceiling heights exceeding 6 m, Ordinary hazard group (OH) I and II risks shall be protected in accordance with ordinary hazard Group III Criteria; or

(b) In areas where ECOH sprinklers are fitted, to include an assumed area of operation of 5 sprinklers, but not less than 140 m^2, discharging in accordance with the listing for the sprinkler head. Interpolation of criteria between listed spacings shall not be used; or

(c) For Group III Special risks, the design area, density of discharge and sprinkler orifice sizes are dependent on the height of the ceiling in the protected area:

  (i) For ceiling heights of up to 6 m, the design density of discharge shall be at least 5 mm/min over a design area of 360 m^2, with the use of K = 8 sprinklers

  (ii) For ceiling heights of up to 11 m, the design density of discharge shall be at least 12 mm/min over a design area of 230 m^2, with the use of K = 11.5 sprinklers

  (iii) For ceiling heights of up to 18 m, the design density of discharge shall be at least 18 mm/min over a design area of 230 m^2, with the use of K = 16 sprinklers

  (iv) For heights in excess of 18 m, the design criteria shall be approved by a Sprinkler System Certifier (SSC). See also table 9.7.

801.2 Water supplies

801.2.1

Each water supply shall be capable of providing at the installation control valves, the design flow at the design pressure, provided that:

(a) In OH2 occupancies other than those protected by ECOH sprinklers, each water supply need provide only ⅔ of the design flow but this shall be provided at the design pressure;

(b) In installations where the pipework downstream of the "18 sprinkler points" (see Note to Design Point definition in 103) has been sized according to table 8.1, each water supply need provide (for the OH occupancy) only the following rates, at the design pressure (see Note):

OH1 occupancy	540 L/min
OH2 occupancy	1100 L/min
OH3 occupancy	1350 L/min

NOTE – In this context, the design pressure is that which is needed at the alarm valves to provide at each "18 sprinkler point":

(1) For OH1 occupancies, 200 kPa when 540 L/min is flowing;

(2) For OH2 and OH3 occupancies, 300 kPa when a flow of 1,350 L/min is assumed to be flowing.

801.2.2

Notwithstanding 606.1.1, in cases where 801.2.1 applies, any storage tank may be sized as if the flows permitted in 801.2.1(a) or (b) were the "design flow".

801.2.3

Where external sprinklers impose a demand greater than that of the protected area, the values of the design flow and design pressure shall be increased accordingly.

801.2.4

Where sprinklers are installed within storage fixtures, the pipework and the water supply shall be sized to comply with both 801.1 and any combination of 18 ceiling level and in-rack sprinklers within the same floor footprint area; these requirements not to be cumulative.

Table 8.1 – Maximum number of sprinklers on tabular pipework

(1) Range pipes

Ranges	**Pipe size (normal diameter)** (mm)	**Maximum number of sprinklers allowed on range pipes**
(a) Ranges at remote end of all distribution pipes		
(i) Two end-side layouts	25	1
Last two ranges	32	2
(ii) Three end-side layouts	25	2
Last three ranges	32	3
(iii) All other layouts	25	2
Last range	32	3
	40	4
	50	9
(b) All other ranges	25	3
	32	4
	40	6
	50	9
NOTE – The number of sprinklers on a range pipe when the ranges run longitudinally under roofs sloping at an angle in excess of 6° shall not exceed 6. This provision shall apply only where ranges are above the elevation of the design point.		

(2) Distribution pipes

Distribution pipes within the array	**Pipe size (normal diameter)** (mm)	**Maximum number of sprinklers to be fed by distribution pipe**
Pipes at extremities of system		
(a) Two end-side layouts		
	32	2
	40	4
	50	8
	65	16
(b) All other layouts	32	3
	40	6
	50	9
	65	18

801.2.5

For new sprinkler systems, ECOH installations or extension of existing sprinkler systems which exceed 18 sprinklers, or which are installed in OH3 Special occupancies, all new pipework shall be sized by full hydraulic calculation in accordance with Part 10, so as to comply with 801.1 and 801.2.

It is not a requirement of this Standard to limit water velocities in pipes.

801.3 Sizing of pipework

Existing sprinkler systems (except OH3 Special occupancies) may be extended by a maximum of 18 sprinkler heads, using pipe sizes determined in accordance with table 8.1. The following criteria apply:

(a) The table, in (c) below, shall be used to size pipes downstream of the "18 sprinkler point";

(b) There shall be available at each "18 sprinkler point", the following minimum design pressure:

OH1 occupancy	200 kPa
OH2 and OH3 occupancies	300 kPa;

(c) To calculate pressure availability at the "18 sprinkler point", allowance shall be made for any difference in height to the alarm valve. The pressure loss due to friction shall be calculated at a flow rate of 540 L/min for OH1 occupancies and 1350 L/min for OH2 and OH3 occupancies using either the Hazen-Williams formula or the following values for loss of pressure per metre length of pipe:

Pipe size (NB) (medium grade) (mm)	**Flow rate 540 L/min** (kPa)	**Flow rate 1350 L/min** (kPa)
50	3.8	21.6
65	1.1	6.0
80	0.51	2.8
100	0.14	0.76
150	0.021	0.11
200	0.005	0.028

A1

(d) Sprinkler spacing of the extension, both between the sprinklers and between the ranges, shall not exceed 3.0 m;

(e) Where range pipework incorporates changes of direction, and pipe sizes are not increased to compensate for the additional friction losses, it shall be demonstrated that the use of pipe sizes to table 8.1 in that situation is not hydraulically worse than the worst case permitted by table 8.1 using straight pipe;

(f) Where the roof or ceiling gradient exceeds 1 in 4, and the ranges are fed up the slope, full hydraulic calculation shall be used.

802 SPRINKLER TYPE AND SPACING

802.1 Sprinkler types

802.1.1
In sleeping areas, sprinkler heads shall be 15 mm quick response.

In this context "sleeping areas" includes bunkrooms, hospital wards, bedrooms, dormitories and indivicual suites in hotels, motels and apartment buildings. "Individual suites" means that area (whether partitioned or not) to which access is controlled by the room key, i.e. bedrooms, bathroom suite, lobby, lounge and kitchen where provided.

NOTE – To achieve comparable detection some ECOH sprinklers are fitted with a more responsive heat activated element, but are not necessarily listed as quick response sprinklers.

802.1.2
In all other areas either quick response or standard response 15 mm sprinkler heads shall be used.

802.1.3
Standard response sprinklers may be used in small ancillary spaces, related to sleeping occupancies, such as cupboards, laundries, toilets and bathrooms, where such spaces are protected by one head.

802.2 Sprinkler spacing

802.2.1
Maximum area coverage per sprinkler shall be:

Sidewall sprinklers	9 m^2
Other sprinklers	12 m^2
ECOH sprinklers	see sprinkler listing.

802.2.2
The maximum distance between sprinklers on range pipes and between adjacent rows of sprinklers (for other than sidewall sprinklers) shall be:

For standard spacing (see figure 5.2)	4.0 m
For staggered spacing	4.6 m between sprinklers on ranges, and
	4.0 m between adjacent rows of sprinklers.

For sidewall sprinklers see 510.

For spacing of ECOH sprinklers see the sprinkler head listing. Notwithstanding 505, ECOH sprinklers shall be installed at least 2.4 metres apart for upright sprinklers, and 2.7 metres apart for pendent sprinklers, or no closer than shown in the listing.

NOTE – In the case of corn, provender and rice mills (other than those using the pneumatic system of conveying), film and television production studios, theatres and music halls (stage protection), the maximum area coverage is limited to 9 m^2 per sprinkler and the maximum distance between sprinklers to 3 m.

Part 9
EXTRA HIGH HAZARD SYSTEM DESIGN DATA

901 SCOPE

901.1

This Part specifies the requirements and provides necessary information and procedures for the design of standard sprinkler system protection for extra high hazard class sprinkler systems incorporating Process Occupancies and Storage Occupancies.

NOTE – The existence of alternative special sprinkler systems incorporating new technologies is recognised (see 401.1).

901.2

This Standard is not intended to provide protection for packaged dangerous goods or flammable liquids.

NOTE – See 203.5.1 for guidance on the protection of flammable liquids.

902 EXTRA HIGH HAZARD CLASS TERMINOLOGY

The following clauses provide brief descriptions of special terms used throughout this Part relating to the storage and protection of commodities. They are unique to this section. For other terms, see 103.

902.1 Aisle

The clear access space normally maintained between commodities stored in racks or on floors.
Aisle width is measured from face of upright to face of upright, or face of storage to face of storage, whichever is the lesser.

902.2 Banded paper

Roll paper that is provided with one or more circumferential steel straps or wires to prevent unwinding.

902.3 Bin box storage

Storage in five-sided containers where the open side faces an aisle. Height of storage is usually less than 4.6 m, with little or no space between containers. The depth of a bin is typically no more than 600 mm.

902.4 Bundled tyres

A storage method in which a number of tyres are strapped together. Bundled tyres may be compressed up to 50 % of their original thickness (see figure 9.1).

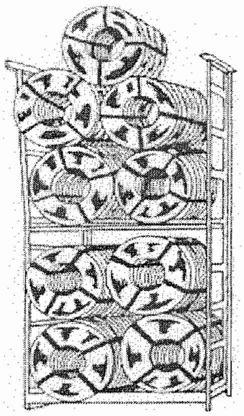


Figure 9.1 – Bundled tyres (with horizontal flue spaces)

902.5 Carpet storage

Carpets are usually made from natural fibres (wool or cotton), man-made fibres or blends. See commentary C907.5.

902.6 Closed array (roll paper storage)

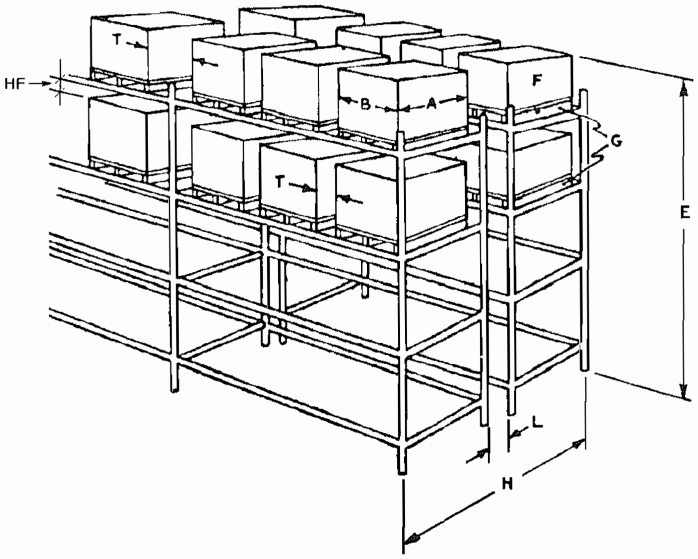
A storage arrangement where uniform diameter rolls, on-end, are in piles of at least four stacks in both directions with stack spacing closer than 100 mm. Closed array is rarely found and usually involves stacking by crane.

902.7 Commodity

The combination of product, packaging material, container, and material handling aids (e.g. pallet), upon which commodity categorisation is based.

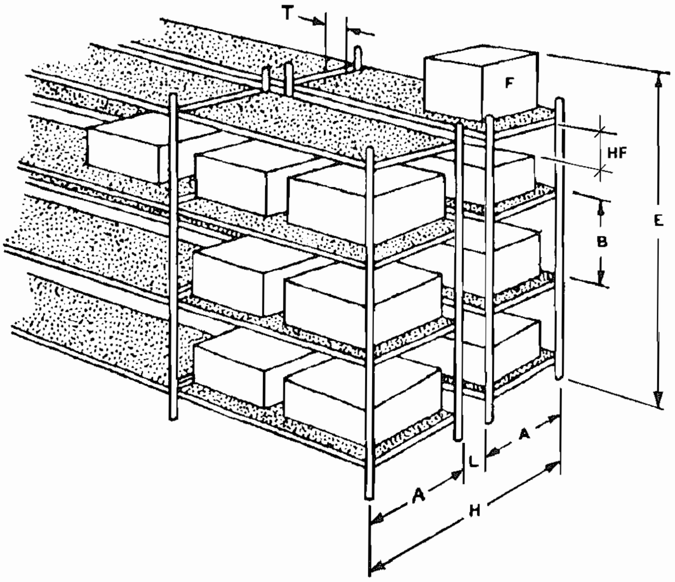
902.8 Double row rack (DRR)

A rack not exceeding 3.7 m in depth, formed by two single row racks placed back-to-back separated by a longitudinal flue space, and separated from adjacent racks by an aisle not less than 1.2 m wide (see figure 9.2(a), (b) and (c)).



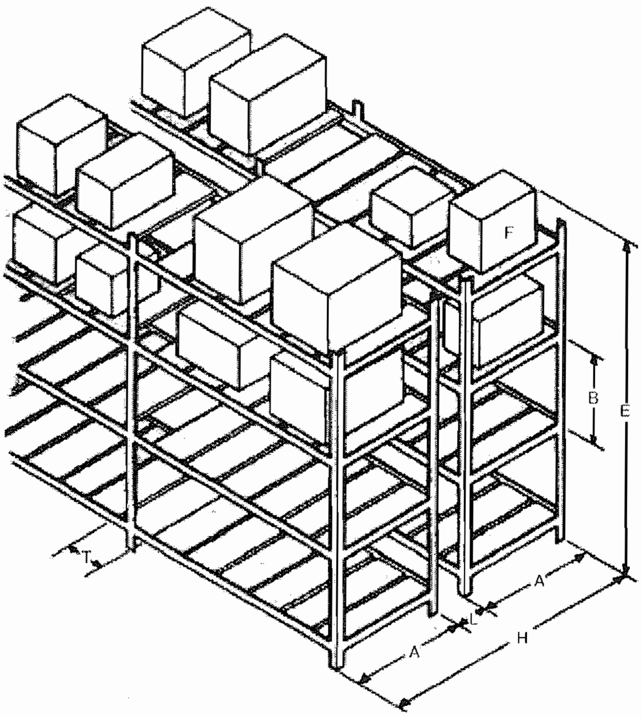
A – Load depth
B – Load width
E – Storage height
F – Commodity
G – Pallet
H – Rack depth
HF – Horizontal flue space
L – Longitudinal flue space
T – Transverse flue space

Figure 9.2(a) – Double row racks – Without solid or slatted shelves



A – Shelf depth
B – Shelf height
E – Storage height
F – Commodity
H – Rack depth
HF – Horizontal flue space
L – Longitudinal flue space
T – Transverse flue space

Figure 9.2(b) – Double row racks – With solid shelves



A – Shelf depth
B – Shelf height
H – Rack depth
L – Longitundinal flue space
E – Storage height
F – Commodity
T – Transverse flue space

Figure 9.2(c) – Double row racks – With slatted shelves

902.9 Draft curtain

A partition, bulkhead or structure extending down, at least 600 mm from the underside of the roof/ceiling. The construction is required to be noncombustible and to fit tightly against the underside of the roof/ceiling. Openings created by channels in a ribbed deck are permitted, however openings created between purlins or other structural members need to be adequately sealed. The rolled lip of Z or C purlins does not need to be sealed off.

Examples of acceptable forms of draft curtain construction include the following:

(a) Structural features such as solid beams, girders or steel joists extending down the minimum required distance from the underside of the ceiling/roof;

(b) A purpose-built partition mounted on timber or steel framework, constructed of 10 mm gypsum board, 0.6 mm sheet steel or 7 mm high-density tempered board.

Appertures are permitted provided that such openings are for the passage of pipes, conduits and mechanical ductwork and are reasonably close fitting. Gaps should be less than 5 mm and not permit the passage of a 5 mm sphere.

902.10 Dunnage (roll paper storage)

Materials, such as wood chocks, wedges and battens, used to raise roll paper commodities from the ground or floor and maintain their placement.

902.11 Encapsulation

A method of packaging consisting of a plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity or a group of combustible commodities or combustible packages. Totally noncombustible commodities on wood pallets, enclosed only by a plastic sheet as described above, are not considered to be encapsulated.

The term ‘encapsulation’ also applies to individual cartons, which are enclosed on the top and sides in plastic, or to cartons waterproofed by coatings on the exterior surfaces. An example of a waterproof carton is one that is used to export sensitive equipment by ship and needs to be protected from the salt-laden atmosphere.

The term ‘encapsulation’ does not apply to individual plastic enclosed items inside a larger nonplastic enclosed or non-waterproofed container. If holes or voids in the plastic or waterproof cover, on the top of the carton, exceed more than half of the area of the top, the term ‘encapsulation’ does not apply.

Encapsulation only affects protection requirements for Category 1, 2, 3 and 4 commodities that are stored in racks and protected by the type of sprinklers nominated in 904.1.1. Protection requirements for solid pile, palletised, shelf and bin box storage are not affected by the presence of encapsulation.

902.12 Face sprinkler

Face sprinklers are in-rack sprinklers used to oppose vertical development of fire on the external face of the storage and to simultaneously provide a water curtain between two adjacent racks to hinder fire spread across the aisle. They are preferably located in transverse flue spaces along the aisle, or in the rack within a maximum distance of 460 mm from the aisle face of storage (see 902.20).

902.13 Flue spaces

The open spaces between rows of storage. In the case of rack storage, the longitudinal flue spaces are perpendicular to the direction of loading, and transverse flue spaces are parallel to the direction of loading, (see figure 9.3). In solid-pile and palletised storage, flue spaces may run in either direction, or be non-existent.

NOTE –

(1) Flue spaces are necessary for rack storage arrangements to allow heat from a fire to vent vertically. This allows the ceiling-level sprinklers (and in-rack sprinklers if provided) to operate as quickly as possible as well as slowing down the horizontal fire spread within the rack. Flue spaces are also necessary to allow sprinkler water penetration down through the racks. Without sufficient water penetration to burning commodities stored on the lower tiers of the racks, fire control may not be achieved. To be effective as outlined above, flue spaces should be a minimum net width of 75 mm and ideally about 150 mm wide. Flue space net width is a measure of its gross width minus any horizontal obstructions, such as rack uprights, located within the flue space. Except where in-rack sprinklers are provided at every tier level, all rack storage arrangements require transverse flue spaces to allow the provided automatic sprinkler protection to be effective. Longitudinal flue spaces are not required within rack storage arrangements; however, if they are provided they should have a minimum 75 mm net clear width vertically throughout the height of the rack. Vertical alignment of flue spaces should be maintained as closely as possible.

(2) Transverse flues between pallet loads are critical to successful fire suppression by suppression mode sprinklers and must be maintained, regardless of building and storage height. For rack storage higher than 7.6 m both longitudinal and transverse flues are needed. In multiple-row rack storage, where pallet loads are butted together in one direction, but there are flues between each row of pallets, a lack of longitudinal flues does not necessarily create a problem for suppression mode protection. The only place where fire can develop vertically is in the flues between rows, and those flues are close together. So long as they are open for the full height of storage, water from properly designed ceiling and/or in-rack sprinklers can reach the fire. The situation where there are open flues at lower levels in racks, that are blocked at higher level does create a severe fire protection challenge as there is a place for fire growth and spread that is shielded from sprinkler discharge. If there are longitudinal flues at any level in the rack, they must be open and clear for the full height of the rack. A common example of this is high rack storage where lift operators cannot see precisely where the pallet loads at the top level, and the longitudinal flue can easily be blocked at that level but remain open at lower levels.

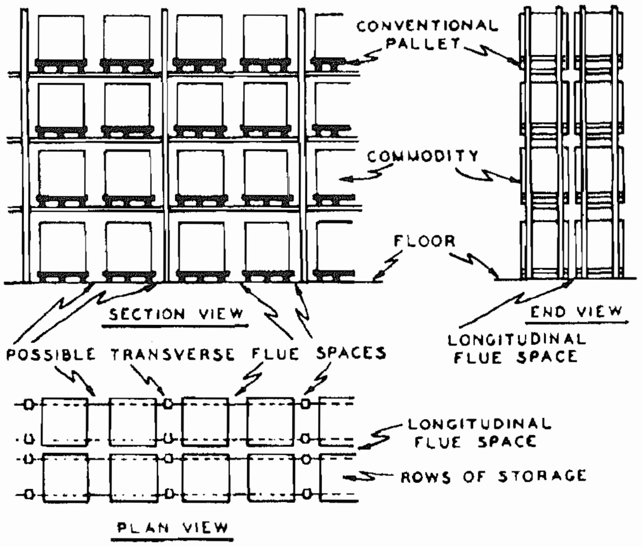
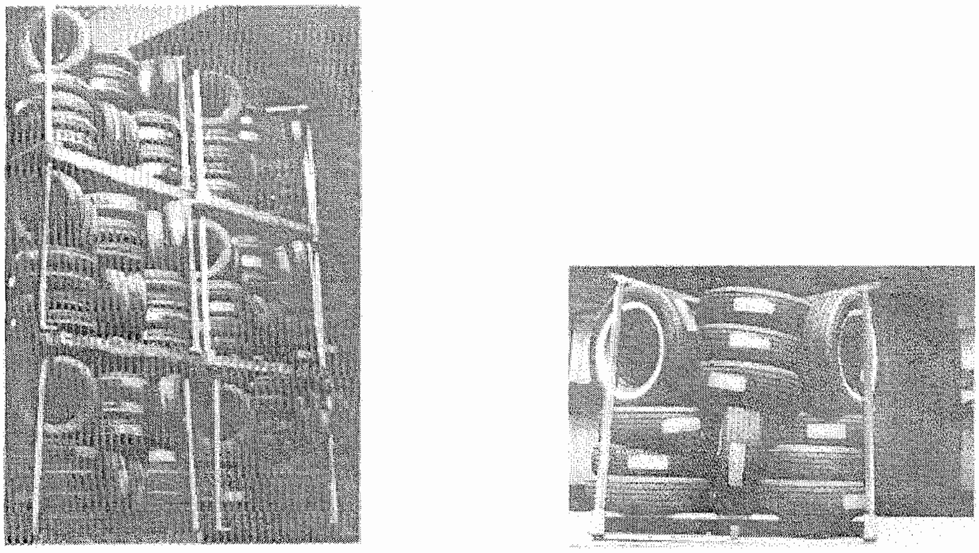


Figure 9.3 – Typical double row (back-to-back) rack arrangement

902.14 Fully loaded (tyre storage)

A portable rack, (see 902.42) is considered to be 'fully loaded' when the open space between the top tyre in one rack and the bottom of the next rack above is less than 300 mm (see figure 9.4(a) and (b)). When the space is 300 mm or more, the load is considered 'partially loaded' (see 902.32).



(a) Example 1

(b) Example 2

Figure 9.4 – Fully loaded (tyre storage)

902.15 Green tyres

A green tyre consists of a tyre 'carcass', cylindrical in shape, approximately 0.4 m diameter by approximately 0.6 m long. The green tyre at this point in the manufacturing process is ready for moulding and curing into a finished tyre. The preparatory process results in a supply of green tyres in storage in the manufacturing area awaiting moulding and curing (see figure 9.5).

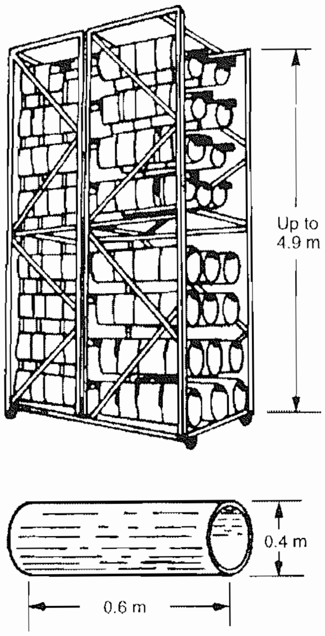


Figure 9.5 – Typical green tyre storage (storage two carts high or 4.9 m high)

902.16 Heavyweight paper (roll paper storage)

All paper that weighs 98 g/m^2 or greater. Examples of paper may include (but are not limited to) liner board, corrugating medium, index, cup board, tag, rolled pulp, folding box board and kraft roll wrappers.

902.17 Horizontal barriers (within and above racks)

Solid barriers on a horizontal plane within or above a rack, beneath which in-rack sprinklers are installed. They extend to both ends and both aisle faces of the racks, and are fitted to within 50 mm of any vertical rack member or other equipment which would create an opening, such as vertical in-rack sprinkler pipe drops. Their purpose is to impede vertical fire spread by blocking off normally open flue spaces, while also helping to achieve prompt in-rack sprinkler operation by banking heat down to the in-rack sprinklers.

NOTE – An example of an acceptable horizontal barrier construction material is plywood with a minimum thickness of 10 mm.

902.18 Horizontal flue space

An uninterrupted space in excess of 1.5 m in length between horizontal layers of storage. Such channels may be formed by pallets, shelving, racks or other storage aids, see figure 9.2(a) – (c).

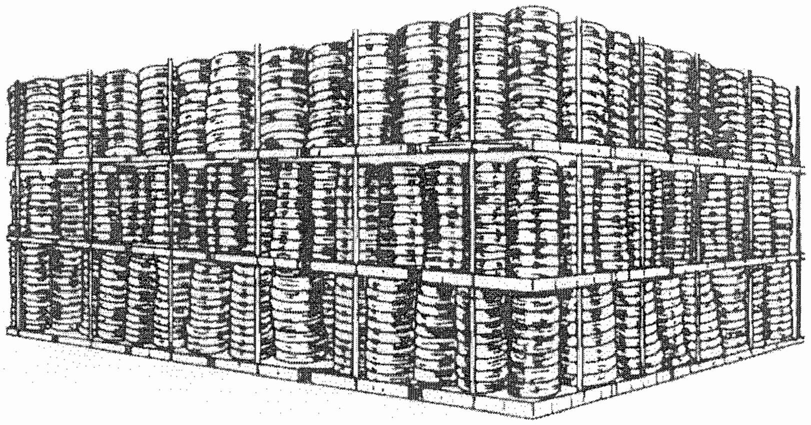


Figure 9.6(a) – Typical storage arrangement – Using pallet-based portable rack (fully loaded)

NOTE – There is a lack of horizontal flue spaces when pallets are fully loaded.

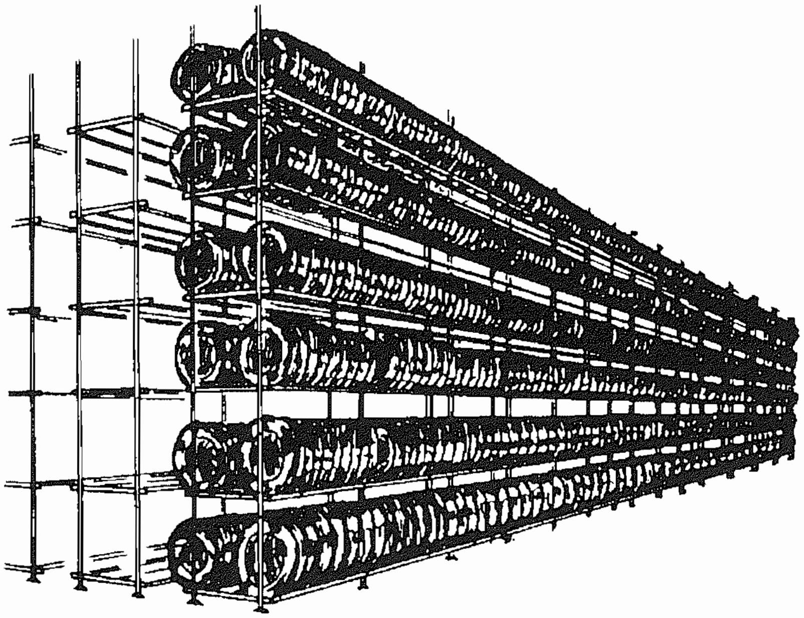


Figure 9.6(b) – Typical storage arrangement – On tread

NOTE – Horizontal flue spaces shown

902.19 In-process non-rack storage (aerosols)

Small quantities, of not more than six pallets, stored not more than one pallet load high.

902.20 In-rack sprinklers (IRS) (also called rack storage sprinklers or intermediate level sprinklers)

In-rack sprinklers are typically located in the longitudinal flues, the transverse flues, or at the face of the rack. Sprinklers within flue spaces oppose vertical fire growth up through the flues. Additionally, face sprinklers, (see 902.12) oppose vertical fire growth on the external face of storage and simultaneously provide a water curtain between two adjacent racks to hinder fire spread across the aisle.

Depending upon the location, the IRS shall be equipped with an integral water shield or fitted with a guard incorporating a shield, which shall be approved and shall be a minimum of 76 mm in diameter. The water shield prevents wetting of the operating element by water from sprinklers at a higher elevation in the rack or at the roof/ceiling. Note that the water shield is not a heat collector and has virtually no effect on how fast the in-rack sprinkler will operate.

902.21 Locations other than warehouses (tyre storage)

Tyre storage in retail stores, fleet garages and service centres. Tyres are usually on-tread in double row racks. One arrangement has tyres six high (approximately 4.8 m) with an open grid mezzanine at the three high (2.4 m) level. Another common arrangement has three high (approximately 2.4 m) storage. Generally aisles are 900 mm wide. The storage areas are usually small; typically not more than 50 % of the total room area (see figure 9.7).

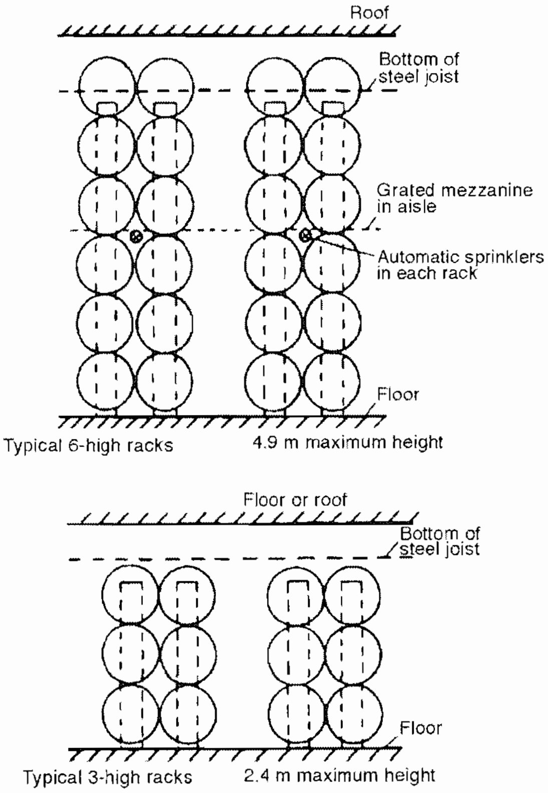


Figure 9.7 – Typical storage arrangements in locations other than warehouses

902.22 Lightweight paper (roll paper storage)

All paper with an absorbent, fibrous or gauze-like texture regardless of weight. Examples may include, but are not limited to, toilet tissue, napkin, crepe, facial tissue and paper towel. Also included in the lightweight paper classification is all paper with a hard, smooth or glossy finish that weighs less than 49 g/m^2. Examples of this grade of paper may include, but are not limited to, onion skin, catalogue paper, fruit wrap, carbonising paper and cigarette paper. Some newsprint may weigh as little as 42 g/m^2.

902.23 Medium weight paper (roll paper storage)

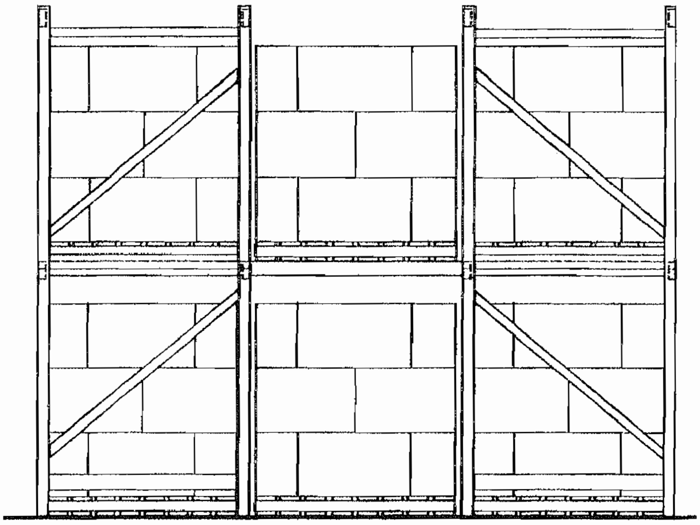
All paper with a hard, smooth or glossy finish that weighs less than 98 g/m^2 but not less than 49 g/m^2. Examples of medium weight paper may include, but are not limited to, newsprint, tablet, computer, envelope, book, butcher, label, bond, magazine, vellum and bag paper.

902.24 Movable rack

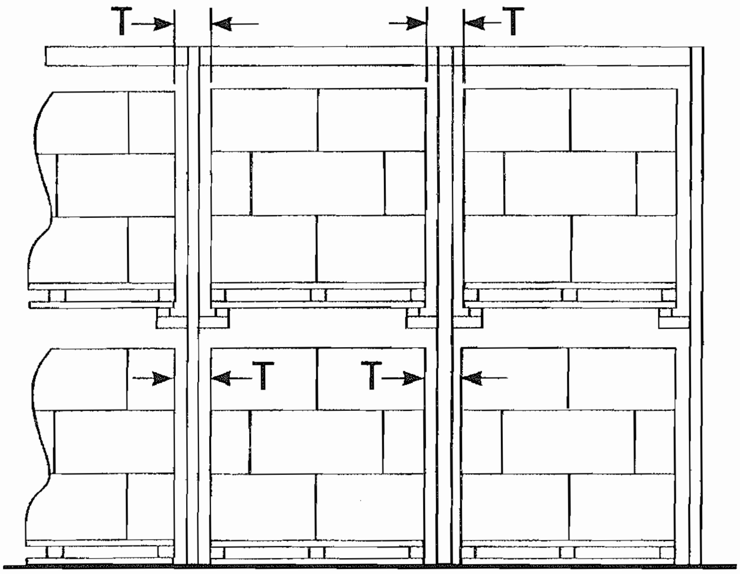
A rack on fixed rails or guides. They can be moved in one direction only in a horizontal two-dimensional plane. A moving aisle is created as abutting racks are either loaded or unloaded, then moved across the aisle to abut other racks. Movable rack arrangements generally result in the same protection needs as for multiple row racks.

902.25 Multiple row rack (MRR)

A rack greater than 3.7 m deep, or a combination of single row or double row racks separated by aisles less than 1.2 m wide having an overall width, including flues, greater than 3.7 m. Multiple row racks can be drive-in, drive-through, flow-through, push-back or double-deep standard racks. The rack depth is the determinant (see figure 9.8(a) – (c)).



End View



Aisle View

T – Transverse flue space

Figure 9.8(a) – Multiple row rack
– Drive-in rack, two or more pallets deep

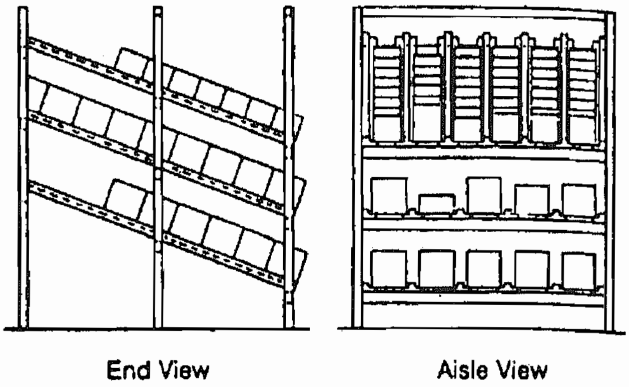
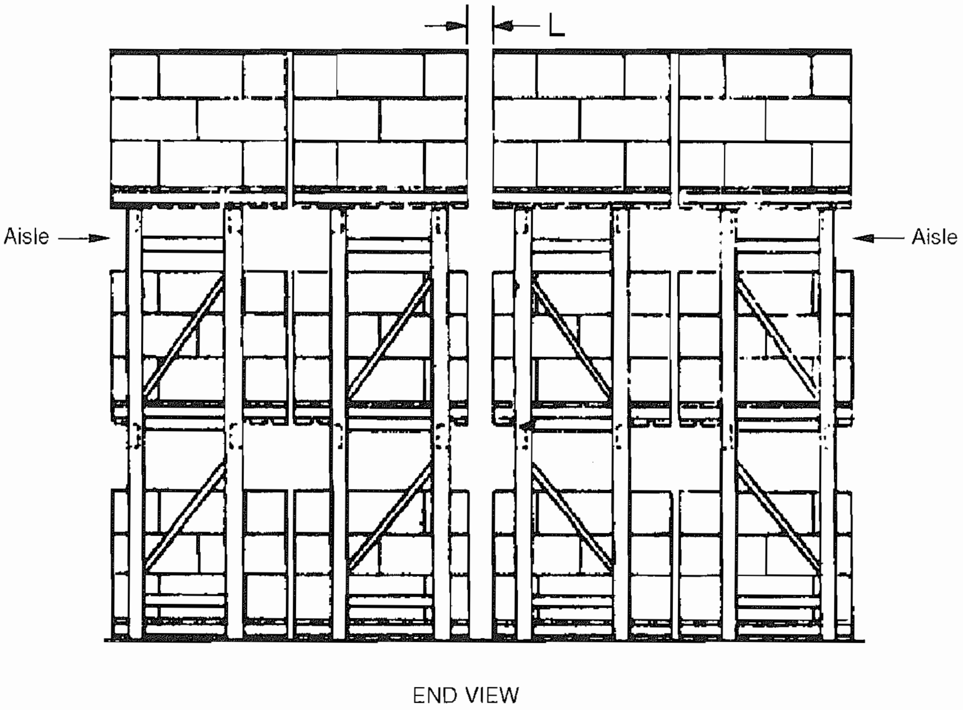


Figure 9.8(b) – Multiple row rack – Flow-through racks



L – Longitudinal flue space

Figure 9.8(c) – Multiple row rack – Double deep rack, serviced by reach (forklifts) truck

902.26 On-floor storage (tyre storage)

Tyres 1.5 m or higher stored directly on the floor, on-side or on-tread, and may be pyramided to provide pile stability (see figure 9.9(a) and (b)).

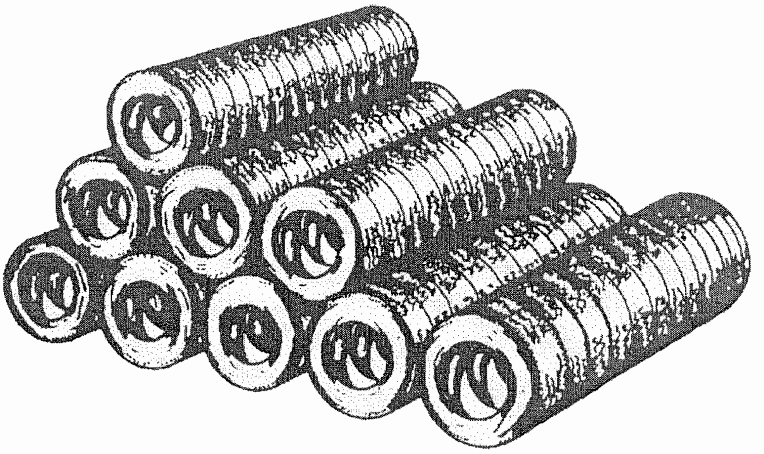


Figure 9.9(a) – On-floor storage
– On-tread storage

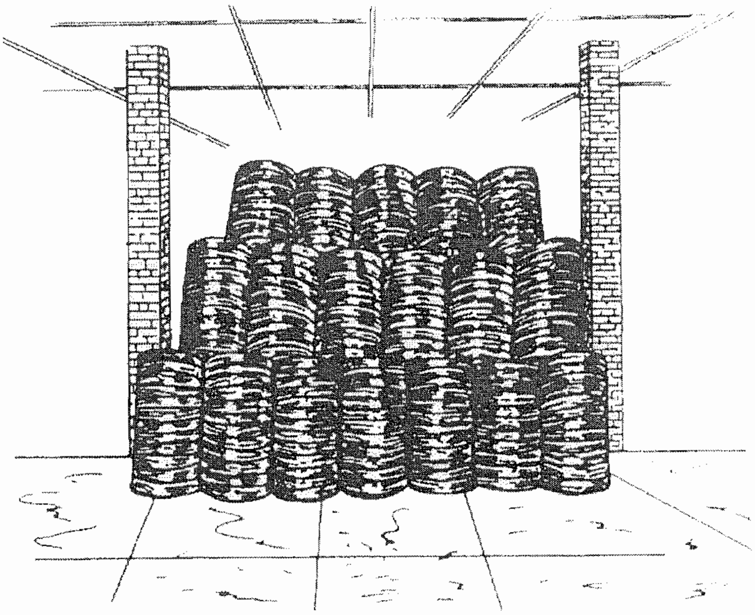


Figure 9.9(b) – On-floor storage
– Pyramid tyre storage, on-side

902.27 On-side storage (tyre storage)

Tyres 1.5 m or higher stored horizontally or flat (see figures 9.9(b) and 9.10).

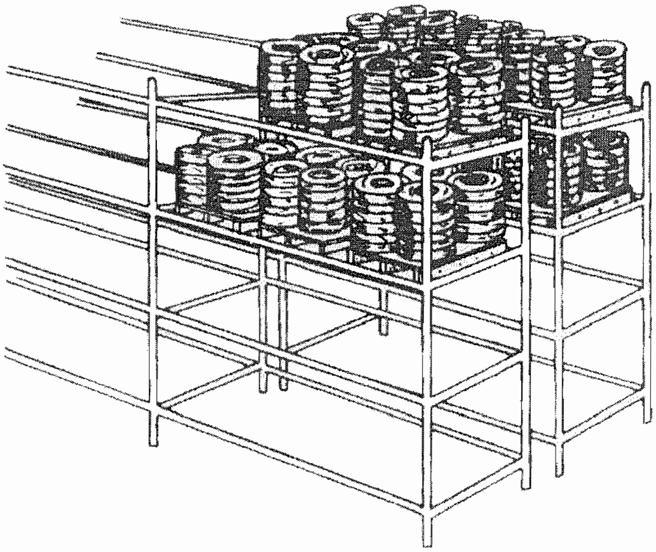


Figure 9.10 – Double row rack storage with on-side palletised storage

902.28 On-tread storage (tyre storage)

Tyres 1.5 m or higher stored vertically or on their treads (see figures 9.6(b), 9.9(a) and 9.11).

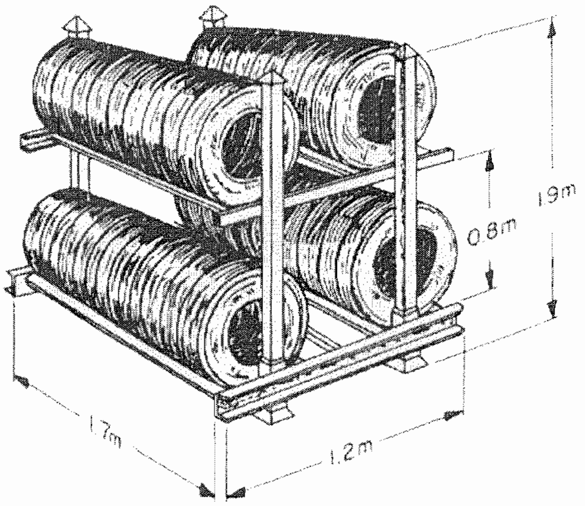


Figure 9.11 – Rack frequently used for on-tread storage

902.29 Open array (roll paper storage)

A storage arrangement where rolls, on-end, are in stacks separated in both directions. Stack separation is 100 mm or more. Open array storage is generally found where rolls are not uniform in diameter and where stacker trucks with clamps are used for handling.

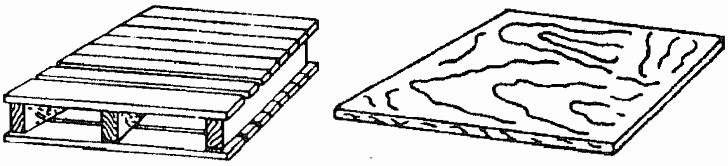
902.30 Open-top combustible containers

Five-sided, open-top containers made of wood, cardboard, plastic, or other combustible materials. They prevent water from running over the top of the container and down the flues and also can collect water from discharging roof/ceiling sprinklers, preventing that water from reaching the lower levels of burning storage, where it is needed to control the fire. Noncombustible open-top containers and open-top containers with non-solid sides, such as wire mesh, do not fall into this category. Timber slatted open top containers also do not fall into this category.

902.31 Palletised storage

902.31.1 *General*

Palletised storage refers to the use of pallets for commodity storage. Pallet loads of storage are placed one on top of another. Pallets are material handling aids upon which unit loads of commodity are placed to ease the transport of commodity from place to place, (see figure 9.12). Pallets may be wood, metal or plastic. Conventional pallets have stringers to accommodate forklift trucks for handling unit loads. Slave pallets (less than 1.9 m^2) are special flat-bottomed pallets captive to a material handling system.



(a) Conventional pallet (b) Slave pallet

Figure 9.12 – Typical pallets

902.31.2 *Tyre storage on pallets*

Palletised storage is also a term used by the tyre industry to designate tyre storage on portable racks, (see 902.33) as shown in figures 9.4, 9.6(a) and 9.11. The conventional piling method is to store tyres on-side when using portable pipe racks. However, using an alternative piling method, tyres are piled both on-tread and on-side, enabling more tyres to be stored per pallet (see figure 9.4).

902.32 Partially loaded (tyre storage)

A portable rack, (see 902.33) is considered to be partially loaded when the open space between the top tyre in one rack and the bottom of the next rack above is 300 mm or more. When the space is less than 300 mm, the loads are considered fully 'loaded' (see 902.14).

902.33 Portable rack

A rack not fixed in place. Portable racks can be arranged in any number of configurations, and include wire baskets without solid sides and bottoms and open-top containers without solid sides but with solid bottoms. Five-sided open-top combustible containers with solid sides and bottoms are treated as open-top combustible containers. Portable rack protection needs are determined by depth of racks as applicable to single row, double row, and multiple row racks, (see figure 9.13).

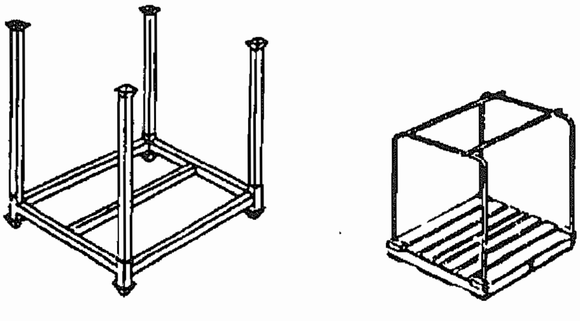
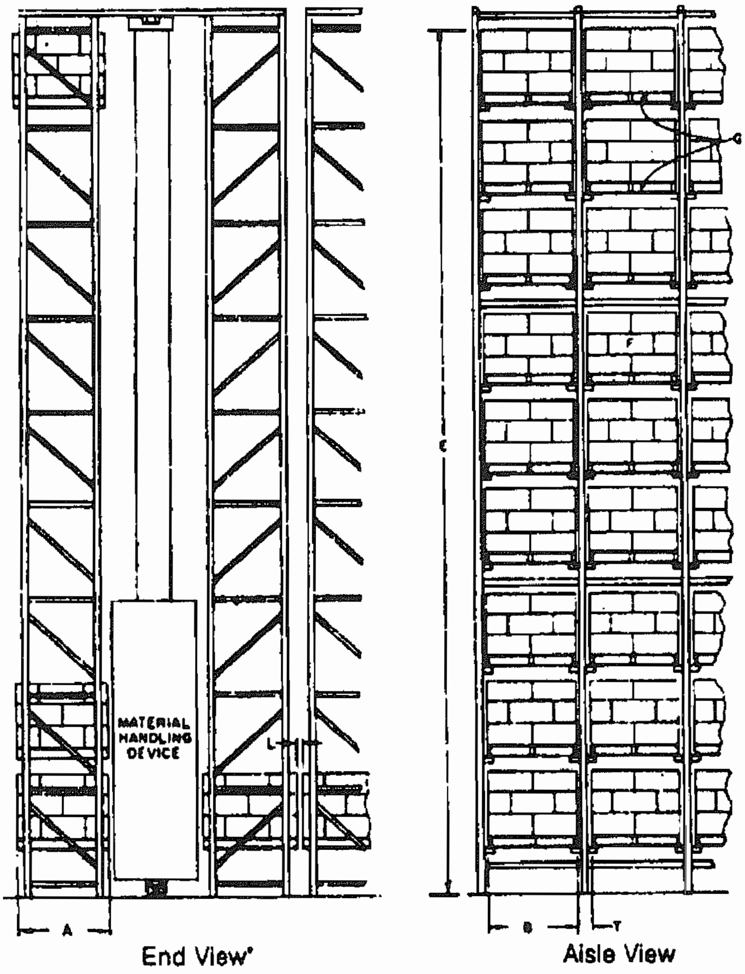


Figure 9.13 – Portable racks

902.34 Rack storage

Storage in racks that use combinations of vertical, horizontal and diagonal members, with or without solid shelves, to support stored material. Racks may be fixed in place or portable, (see 902.33). Loading may be manual (using forklift trucks, stacker cranes, or hand placement) or automatic (using machine-controlled storage and retrieval systems), (see figures 9.14(a), (b), (c) and (d)).



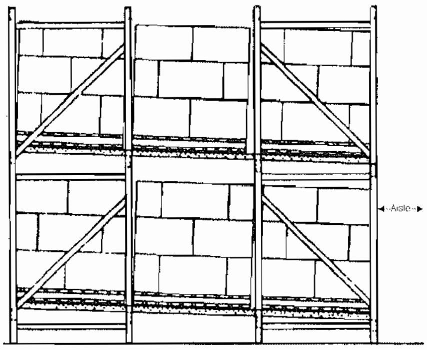
End View*

Aisle View

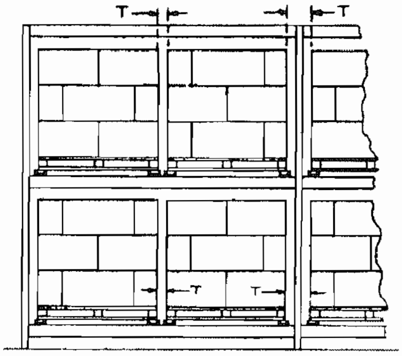
A – Load depth
B – Load width
T – Transverse flue space
L – Longitudinal flue space

E – Storage height
F – Commodity
G – Pallet

Figure 9.14(a) – Rack storage – Automatic storage type rack



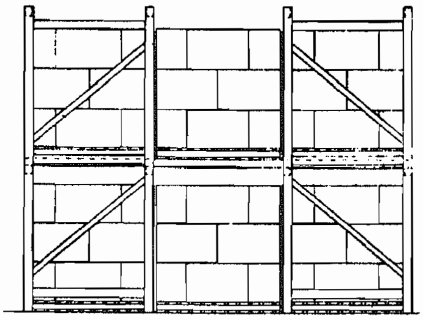
End View



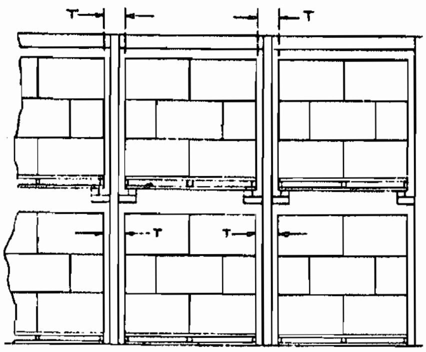
Aisle View

T – Transverse Flue Space

Figure 9.14(b) – Rack storage
– Flow-through pallet rack



End View



Aisle View

Figure 9.14(c) – Rack storage
– Drive-in rack, two or more pallets deep – Forklift truck drives into rack to deposit or withdraw loads in the depth of the rack

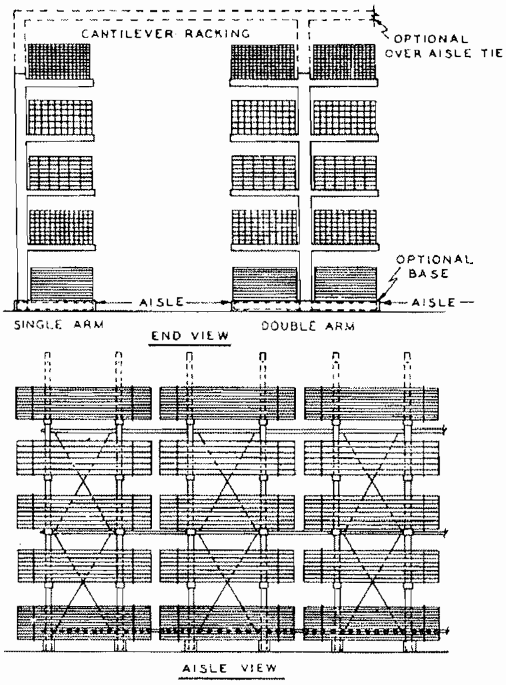


Figure 9.14(d) – Rack storage – Cantilever rack

902.35 Roof/ceiling sprinklers

Sprinklers fixed to the underside of the roof structure, or in the case of suspended ceilings, the sprinklers installed at the ceiling surface.

902.36 Shelf storage

Storage on a structure where solid shelves are less than 800 mm deep, measured from aisle to aisle, are usually less than 600 mm apart vertically. Storage height is usually not greater than 3.6 m, with 800 mm aisles and should not be confused with palletised rack storage on solid shelving, (see 902.39).

902.37 Single row rack

A rack with a depth not exceeding 1.8 m, separated from adjacent racks by an aisle not less than 1.2 m wide. Single row racks have no longitudinal flue spaces. Single row racks with a depth exceeding 1.8 m shall be considered as double row racks. Single row racks separated from adjacent racks by an aisle of 1.2 m or less shall be regarded as Multiple Row Racks (MRR).

902.38 Solid-pile storage

On-floor storage, without pallets or other material handling devices. Unit loads are placed on top of each other leaving no horizontal spaces between unit loads.

902.39 Shelving, solid or slatted

Shelving that is fixed-in-place solid, slatted, or other types of shelves located within racks. Solid shelves in racks, (see figure 9.2(b)) can promote horizontal fire spread throughout the racks and obstruct sprinkler water penetration down through the racks. The area of solid shelf is defined by minimum 150 mm flue spaces at all four edges of the shelf. However, lesser flue spaces are acceptable if there is as least 75 mm of completely open flue space vertically, with no horizontal or vertical rack members obstructing that space.

For example, 125 mm flues that have 50 mm wide horizontal rack members within the space, would be acceptable because at least 75 mm of the total flue space is completely open.

Racks with fixed slatted shelves, (see figure 9.2(c)) having uniform openings of at least 50 %, with the maximum slat width between openings not exceeding 150 mm and with at least 75 mm transverse flue spaces at rack uprights, or at least every 3.1 m of rack length, can be treated as racks without solid shelves, (see figure 9.2(a)). Racks with grated, mesh or other types of shelves having uniform openings not more than 150 mm apart, comprising at least 70 % of overall shelf area, and with adequate flue spaces between blocks of storage on the same rack level, can be treated as racks without solid shelves.

Multiple row racks that have pallet loads abutting in one direction, and with transverse flue spaces on each side of each abutting row, are not considered to be rack storage having solid shelves. Racks with slats that are not fixed in place should be treated as solid shelves.

Portable racks, (see 902.33) having solid bottoms not exceeding 1.9 m^2, and having flue spaces at least equal to those needed for multiple row racks, are not considered to be rack storage having solid shelves. Rack storage of nested or pyramided rolled fabric storage on side, or rack storage of other products which can create large shielded areas, with no chance for sprinkler water penetration, need to be evaluated carefully. It may be necessary to treat such storage as rack storage having solid shelves, depending on the total area of shielding and the degree of obstruction to water penetration.

902.40 Standard array (roll paper storage)

A storage arrangement where uniform diameter rolls on-end, are in stacks abutting in one direction and 100 mm or more apart in the other direction. The standard array is the most commonly used array for roll paper storage. The standard array is generally found where rolls are uniform in diameter and clamp trucks are used for storage.

902.41 Storage height

Maximum height of storage measured from the floor to the top surface of the uppermost level of stored material.

902.42 Tyre rack (tyre storage)

Any combination of vertical, horizontal and diagonal members that support tyres. Racks may be fixed or portable, (see 902.33). Some portable racks use a wood pallet as the base. Portable racks, are called palletised storage in the tyre industry, (see figures 9.4 and 9.15).

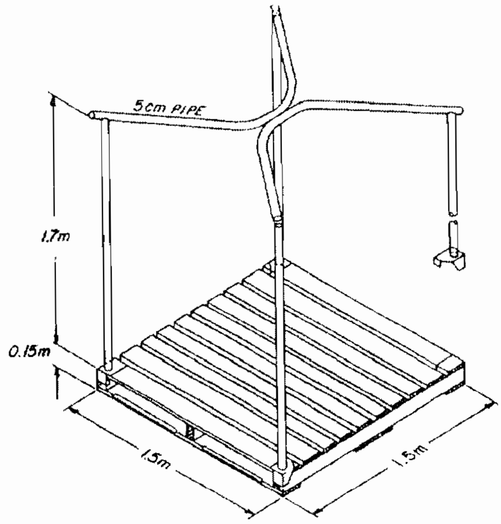


Figure 9.15 – Portable rack using wood pallet base and steel frame

902.43 Vertical barriers

Solid barriers on a vertical plane within a rack extending to the entire height and depth of the rack arranged to limit horizontal fire spread.

NOTE – Examples of acceptable vertical barrier construction materials include the following:
(1) Suitably fixed and supported sheet metal, minimum thickness 0.76 mm;
(2) Plywood, minimum thickness 9.5 mm for all commodities except in the case of idle pallets where the minimum thickness should be 19 mm.

903 GENERAL SYSTEM DESIGN REQUIREMENTS

903.1 Wet systems

Where there is no likelihood of freezing, extra high hazard class sprinkler systems shall be a wet type. extra high hazard class wet sprinkler systems shall comply with the requirements of 302.1 and this section.

903.2 Freeze protection

Where there is a likelihood of freezing, a dry pipe system, an antifreeze system (if specifically listed), or a pre-action type system shall be installed. Unless otherwise noted in this Standard, the area of operation for dry pipe or pre-action shall be increased by 30 %.

NOTE – This clause requires that antifreeze systems be listed. Fire testing has been carried out of common antifreeze solutions that indicate that they may fuel the fire. It is not the intent of this Standard to allow the use of antifreeze based systems, unless their suitability has been demonstrated by full scale fire testing. At the time of drafting this Standard, one manufacturer has listed a suppression-based sprinkler system, with a premixed propylene glycol solution, limited to the protection of Class 1 and Class 2 commodities.

Extra high hazard class dry or pre-action sprinkler systems shall comply with the requirements of 302.2, 302.3, 302.4, 302.5 or 302.6 as appropriate, and this section.

Gridded pipework configurations are not permitted for extra high hazard class dry or pre-action sprinkler systems.

903.3 Dry pipe systems

See 302.2 and 302.3 for requirements for the installation of dry systems.

FM Data Sheet 8-29 may assist in the reliable design of dry pipe sprinkler systems for cool or cold stores.

903.4 Process occupancies

Process occupancies have processes using materials mainly of a hazardous nature likely to develop into rapidly and intensely burning fires, but with small, scattered amounts of in-process storage.

See 203.4 for categorisation of process occupancies and 905.11 for Sprinkler System Design Criteria.

903.5 Storage Occupancies

Extra high hazard storage occupancies consist of goods and materials likely to produce exceptionally intense fires with a high rate of heat release. They are often piled or stacked at heights that can increase the fire challenge.

The design density for extra high hazard storage occupancies depends on the hazardous nature of the stock and the height of storage. These extra high hazard storage occupancies are subdivided as follows:

(a) Categorised Commodities, including rack storage, solid pile, palletised, shelf and bin box storage of commodity Categories 1 to 6 (Categories 5 and 6 include plastics);

(b) Special Commodities including roll paper, idle pallets, rubber tyres, hanging garments, baled fibres and waste paper, carpet and aerosols.

See Appendix B for categorised and special commodity listings, and the design decision trees (see figures 9.22 and 9.25) for guidance in selecting the appropriate sprinkler system design criteria.

C903.5

Storage fires tend to be very severe. In solid blocks of storage, a fire typically develops on an exterior face of the pile and travels upward, spreading out in a fan-shaped pattern.

Not only does the fire at the base pre-heat the material above to prepare it for burning, but the radiant heat from this flame usually comes in contact with a parallel, vertical surface in nearby storage preparing it too for burning. Eventually, the surface ignites. Once the fire is established in both parallel vertical surfaces, the radiation and re-radiation of heat between the surfaces results in a fast developing, very severe fire. The rapidly rising air column makes penetration by roof/ceiling sprinkler water very difficult. This face-fire development depends on the surface material. For example, it is almost as rapid and intense on paper bags containing empty steel cans as it is on cartons of combustibles. However, fire duration depends mostly on the materials within the containers.

Generally, the larger the spaces within a pile the more severe the fire because of the availability of combustion air. Conversely, the more a pile is closed, the less severe the fire will be. The fire intensity also increases with pile height.

The severity can be further enhanced by horizontal spaces, such as those between rack levels. This space allows the fire to burn from one aisle to another and also shields the fire from sprinkler water applied from above.

The more stable a pile is, the more severe the fire will be because surfaces are held in a position that is ideal for burning. Conversely, early pile collapse usually contributes to fire control.

Rack storage adds further complications. It exaggerates the above phenomena, usually increases the number of burning surfaces, allows for adequate combustion air and holds the combustibles in a stable arrangement that is ideal for burning. Sprinkler water has difficulty penetrating through narrow vertical spaces in racks.

The narrower and higher the space, the less penetration can be expected. The overall result is a persistent fire that needs manual assistance with small hose streams for control and mop-up operations.

A bin box storage fire usually will spread up the open face and into the bins. Even though the fire inside the box is shielded from sprinkler water, adequate water will confine the fire to the boxes until manual aid arrives. Shelf storage will behave similarly.

Metal and fire resistant-treated wood pallets may retard initial fire development. However, after the fire is established, it continues in about the same way as fire in material on untreated wood pallets.

The severity of the fire, of course, depends on the material burning. Generally, plastics and synthetics tend to burn more furiously than natural or ordinary combustibles.

903.6 Incidental extra high hazard storage

Where extra high hazard storage is secondary to the primary ordinary hazard group 3 classification within the same compartment, it may be determined to be 'incidental' and the design requirements of the primary occupancy classification shall apply, subject to the following requirements:

(a) The extent of any single area of extra high hazard storage shall not exceed 20 m^2;

(b) The height of the extra high hazard storage shall not exceed 3 m; and

(c) Where there is more than one area of secondary extra high hazard storage, the separation between the perimeters of adjacent areas shall be not less than 9.2 m.

If the extra high hazard storage is determined as not 'incidental', the design requirements of 904.1.4 shall apply.

NOTE – This is intended to apply to small areas of EHH storage in areas of ordinary hazard occupancy, such as in manufacturing areas. If the areas of incidental storage exceed the parameters stated (for height, area or separation) the design should be evaluated in terms of either an EHH storage risk, or, alternatively, if the storage heights for commodities are less than those given in 203.3.4, the classification could remain an ordinary hazard risk.

903.7 Air handling plant

For extra high hazard risks, unless engineering analysis states otherwise, air handling plant shall be automatically shut down on detection of fire.

904 GENERAL HYDRAULIC DESIGN REQUIREMENTS

904.1 Roof/ceiling sprinklers

904.1.1 *Sprinkler types*

Roof/ceiling sprinklers for Storage Occupancies, shall be 15 mm or 20 mm orifice standard spray type (SSP or SSU), extra large orifice (ELO), suppression mode or control mode specific application (CMSA) sprinklers.

NOTE – CMSA sprinklers were formerly known as large drop sprinklers and suppression mode sprinklers were formerly known as ESFR sprinklers. This edition of this Standard now recognises the newer generation of such sprinklers, with differing *K* factors.

Roof/ceiling sprinklers for process occupancies, shall be 15 mm or 20 mm orifice standard spray type (SSP/SSU), or extra large orifice (ELO), or extended coverage high hazard (ECHH).

Roof/ceiling sprinkler types for Special Commodities shall be in accordance with the requirements as specified for the particular special commodity.

Spray sprinklers with a *K* factor of 8 shall only be used for roof/ceiling level densities of up to 10 mm/min.

Spray sprinklers with a *K* factor of 11.5 shall only be used with roof/ceiling level densities of up to 15 mm/min.

NOTE – Full scale fire testing has demonstrated that for a given density of discharge, the use of larger orifices in high piled storage fires will result in few sprinklers operating, with lower levels of damage to commodities.

904.1.2 *Temperature ratings*

Roof/ceiling sprinklers for process occupancies or categorised commodities, shall have a nominal temperature rating as defined in table 9.1 for standard sprinklers or a temperature rating in accordance with the requirements of a selected CMSA or suppression mode sprinkler.

Table 9.1 – Temperature ratings of spray sprinklers

Sprinkler *K* factor (L/min kPa$^{-0.5}$)	Temperature rating °C
8	141 °C
11.5	141 °C
16	141 °C or 68 °C
20	141 °C or 68 °C
24	141 °C or 68 °C
36 EC	141 °C or 68 °C

Temperature ratings for special commodities shall be in accordance with the requirements as specified for the particular special commodity.

904.1.3 *Location and orientation*

For process occupancies or categorised commodities, sprinklers shall be located in accordance with the requirements of Part 5.

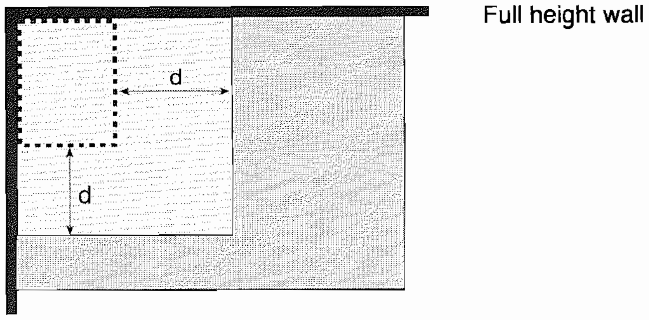
For special commodities, sprinklers shall be in accordance with the requirements of Part 5 unless otherwise specified for the particular commodity.

904.1.4 *Extension of higher hazard into lower hazard*

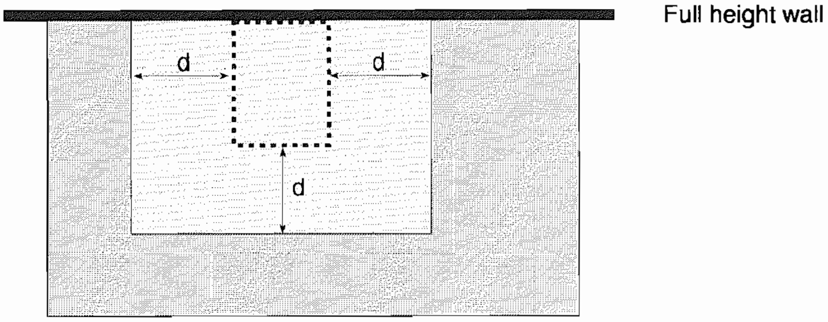
Where ceiling sprinklers have the same RTI, temperature rating, and where two adjacent areas within the same compartment are protected to requirements of differing design criteria, the design for the higher hazard shall be extended into the lower hazard area at least 4.6 m beyond the perimeter of the higher hazard area, or to a full height wall, see also 905.4.

Where an area of higher hazard is surrounded by a draft curtain and a clear aisle of 3.0 m is kept, centrally located below curtain board, then differing RTI and temperature ratings can be used without extending the area of higher hazard protection.

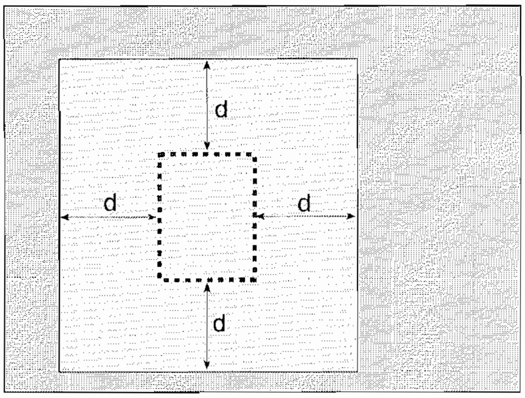
Figure 9.16 details several typical extra high hazard class storage arrangements with adjacent areas of differing design requirements.



(a) Corner storage area



(b) Side storage area



(c) Island storage area

.... Perimeter of higher hazard storage area

▬ Perimeter of building/compartment (full height wall)

☐ Higher hazard design density

▨ Adjacent (lower hazard) design density

d = minimum extension of higher hazard into lower hazard,
see 904.1.4

Figure 9.16 – Examples of adjacent areas with differing design criteria

904.1.5 *Spacing of roof/ceiling sprinklers*

The spacing of 15 mm or 20 mm orifice Standard Spray type, or Extra Large Orifice roof/ceiling sprinklers, for Process Occupancies or Categorised Commodities, shall be in accordance with the following requirements:

(a) The maximum distance between sprinklers along range pipes and between adjacent rows of sprinklers shall be 3.7 m (see figure 5.2);

(b) The minimum distance between any two adjacent sprinklers shall be 1.8 m (see 505.1);

(c) The distance of roof/ceiling sprinklers from walls or partitions shall not exceed half the design spacing.

The spacing of sprinklers for Special Commodities shall be in accordance with the requirements as specified for the particular Special Commodity.

904.1.6 *Maximum area coverage per roof/ceiling sprinkler*

The area covered by each sprinkler shall be defined by lines drawn midway between adjacent sprinklers at right angles to the line joining the sprinklers (see 1003.2 and 1003.3).

For Process Occupancies or Categorised Commodities, the maximum area coverage per roof/ceiling sprinkler of 15 mm or 20 mm orifice Standard Spray type, shall be in accordance with table 9.2.

Table 9.2 – Maximum area coverage per roof/ceiling sprinkler

Design density for design area (mm/min)	**Maximum area of coverage** (m^2)
Up to 10	12.0
Greater than 10	9.0

The maximum area coverage per roof/ceiling sprinkler for Special Commodities shall be in accordance with the requirements as specified for the particular Special Commodity.

904.2 In-rack sprinklers

In general, the following requirements also apply to in-rack sprinklers used with control mode specific application and suppression mode sprinklers. Any variations are stated in 908 and 909 respectively.

904.2.1 *Types and temperature ratings*

Sprinklers within racking shall have a nominal temperature rating of 74 °C or less and shall be specifically listed, approved and manufactured with an integral water shield (see 902.20). Standard Spray Sprinklers may be installed where fixed solid shelves or horizontal barriers shield in-rack sprinklers from pre-wetting by sprinklers above. The use of specifically listed sprinkler guards, with an integral water shield shall meet these requirements, when fitted to Standard Spray Sprinklers.

904.2.2 *Location and orientation*

Sprinklers within racks shall be positioned so that there is not less than 150 mm clearance between the deflectors and the top of the storage immediately below the line of sprinklers.

Sprinklers in longitudinal flues shall be located at the intersection of a transverse and longitudinal flue wherever possible. While sprinklers may be located behind vertical rack uprights, sprinkler deflectors shall, at all times, be located below horizontal rack members.

The horizontal distance to the first in-rack sprinkler, from the end of the rack, shall be not more than half the maximum spacing specified in table 9.3.

Face sprinklers shall be located not more than 460 mm from the aisle face and positioned so that sprinkler discharge is not obstructed from reaching the aisle face of the storage. Face sprinklers located behind or adjacent to rack uprights shall be at least 75 mm clear of the uprights.

Wherever any rack or building structural member is likely to significantly interfere with water discharge distribution from sprinklers, additional sprinklers shall be installed.

Provision shall be made for the protection of pipework and sprinklers against mechanical damage.

NOTE – This clause does not mandate that in-rack sprinklers be fitted with guards.

904.2.3 *Connection to distribution pipes attached to the building structure*

Where storage racks are freestanding, and the in-rack sprinklers are fed by distribution pipes attached to the building structure, the rack pipework shall be connected to the distribution pipes by flexible pipes or seismic flexible joints. (See figure 4.1 for an example of a seismic flexible joint.)

Flexible pipes shall be approved and contain a continuous pressure-retaining stainless steel or non-ferrous metal inner tube.

Flexible pipes shall not be fitted in the fully extended condition.

904.2.4 *Horizontal spacing – Storage height up to 7.6 m*

In-rack sprinklers shall be spaced horizontally as set out below:

(a) *Single row and double row racks up to 2.7 m deep, without solid shelves.* In single row racks up to 1.8 m in depth the in-rack sprinkler line shall be located centrally except where it is susceptible to damage, the line may be located on the non-loading side of the rack. Where single row racks exceed 1.8 m up to 2.7 m in depth, the in-rack sprinkler line shall be located centrally. Sprinkler heads shall be located at least at every alternate transverse flue or alternate gap between pallets, subject to the spacings not exceeding the requirements of table 9.3.

    In double row racks, the in-rack sprinkler line shall be located in the longitudinal flue space, with the sprinklers located at least at every alternate junction of a transverse and longitudinal flue or alternate gap between pallets, subject to the spacings not exceeding the requirements of table 9.3.

(b) *Single row and double row racks, greater than 2.7 m and up to 3.7 m deep, without solid shelves.* In single row and double row racks without solid shelves, greater than 2.7 m deep and up to 3.7 m deep, two lines of in-rack sprinklers shall be provided at each in-rack sprinkler level. The distance between the two lines, and the distance of the two lines from the aisle faces shall be approximately equal. The in-rack sprinklers shall be staggered in relation to those in the tiers immediately above and below, be located in the transverse flues or over gaps between the pallets, and where possible within the longitudinal flues.

    The maximum longitudinal spacing between in-rack sprinklers shall be as nominated in table 9.3.

    Single row and double row racks deeper than 3.7 m shall be treated as multiple row racks.

Table 9.3 – Maximum in-rack sprinkler horizontal spacing (racks without solid shelves)

Rack arrangement	Category/maximum sprinkler spacing (m)		
	1 and 2	3	4, 5 and 6
SRR and DRR with aisle width of 1.2 m to 2.4 m and/or rack depth up to 3.7 m	3.7	3.1	3.1
SRR and DRR with aisle width greater than 2.4 m and/or rack depth up to 3.7 m	3.7	3.7	3.1
MRR, SRR or DRR with aisle width less than 1.2 m and/or SRR or DRR with rack depth greater than 3.7 m	3.7	3.7	3.1

(c) *Multiple row racks without solid shelves.* In multiple row racks without solid shelves, in-rack sprinklers shall be located and spaced in accordance with table 9.3. Figure 9.17(a) or (b) shall also apply as appropriate.

Where only one level of in-rack sprinklers is installed, they shall be staggered horizontally with respect to those sprinklers in adjacent lines, (see figure 9.17(a)).

Where multiple levels of in-rack sprinklers are installed, sprinklers at each level shall be staggered vertically with respect to those sprinklers on levels above and below, (see figure 9.17(b)).

The maximum area coverage per in-rack sprinkler shall be as nominated in 904.2.7.

A1

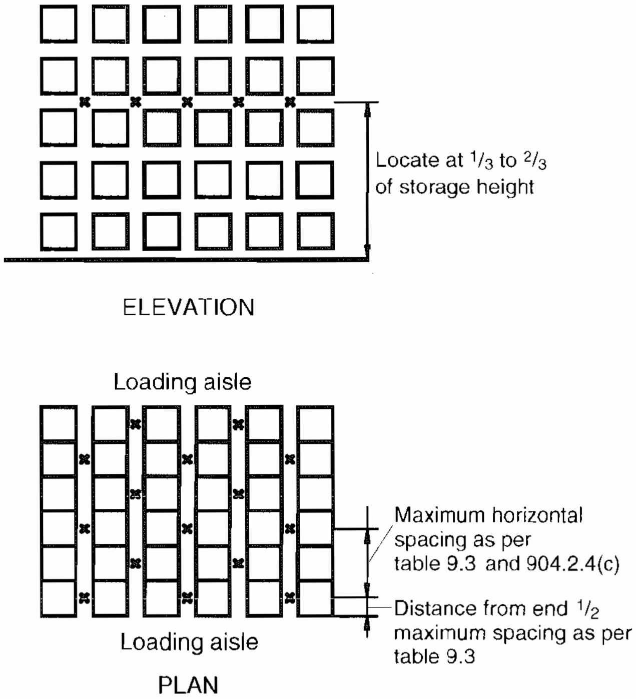

Locate at $^1/_3$ to $^2/_3$ of storage height
ELEVATION
Loading aisle
Maximum horizontal spacing as per table 9.3 and 904.2.4(c)
Distance from end $^1/_2$ maximum spacing as per table 9.3
Loading aisle
PLAN

Figure 9.17(a) – Multiple row racks up to 7.6 m high – Only one level of in-rack sprinklers

A1

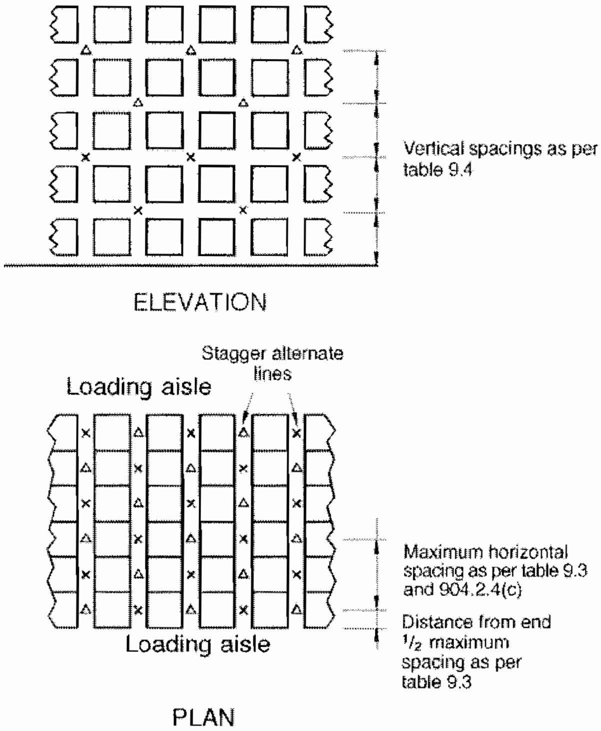

Vertical spacings as per table 9.4
ELEVATION
Stagger alternate lines
Loading aisle
Maximum horizontal spacing as per table 9.3 and 904.2.4(c)
Distance from end ½ maximum spacing as per table 9.3
Loading aisle
PLAN

Figure 9.17(b) – Multiple row racks up to 7.6 m high – More than one level of in-rack sprinklers

(d) *Racks with solid shelves.* Where in-rack sprinklers are installed in racks with solid shelves, the requirements of this clause shall be followed as closely as possible. However, when there are flue spaces in the shelves, the in-rack sprinklers shall be located over the flues (especially the transverse flues) wherever possible. Increases up to 600 mm, in the sprinkler horizontal spacings nominated in table 9.3 are acceptable in order to achieve location over flue spaces in solid shelves only.

904.2.5 *Vertical spacing – Storage height up to 7.6 m*

In-rack sprinklers shall be spaced vertically in accordance with table 9.4.

Table 9.4 – In-rack sprinkler vertical spacings, storage height up to 7.6 m

Number of levels of in-rack sprinklers	Vertical spacing
One	$^1/_2$ to $^2/_3$ of storage height
Two	$^1/_4$ to $^1/_3$ and $^2/_3$ to $^3/_4$ of storage height
More than two	Locate so that approximately equal heights are protected by each level of in-rack sprinklers and roof/ceiling sprinklers

904.2.6 *Horizontal and vertical spacing – Storage height greater than 7.6 m*

Horizontal and vertical spacing of IRS shall be in accordance with the requirements of the relevant tables as determined by the design decision tree, figure 9.22.

904.2.7 *Maximum area coverage per sprinkler in multiple row racks*

The maximum area coverage per in-rack sprinkler installed within multiple row racks, and single row racks or double row racks with aisle width less than 1.2 m, shall be as follows:

(a) Category 1, 2 and 3 commodities.. 9.6 m^2

(b) Category 4, 5 and 6 commodities.. 7.4 m^2.

904.2.8 *In-rack sprinkler installation control assemblies*

A supervised subsidiary stop valve may be provided to allow the rack sprinklers to be isolated without isolating roof level protection.

904.3 Sprinkler protection of concealed spaces

Should a concealed space (including ducts or plenums) be formed partially or wholly of EPS panel or similar then the requirements of 212 shall apply.

904.4 Sprinkler protection of exposed steel building columns

Where rack, solid-pile, shelf, bin-box or palletised storage is greater than 4.6 m in height and is protected by spray or ELO sprinklers at the ceiling or roof level only, in accordance with this section, and exposed steel building columns, or vertical rack members that support the building structure, are within the storage array, sprinkler protection shall be provided in accordance with the following requirements, as appropriate:

(a) A sidewall sprinkler installed on each building column, located between 3.1 m to 4.6 m elevation, pointed towards one side of the steel column, capable of providing a flow rate of at least 114 L/min. The flow rate from each sidewall sprinkler within the design area shall be added to the flow rate required for roof/ceiling sprinklers when sizing system pipework. At the point where column protection pipework meets the roof/ceiling pipework, the respective flows shall be balanced in accordance with the requirements of Part 10; or

(b) For hollow tube or box columns provide two sidewall sprinklers, on opposite corners of the column, directed at the column located between 3.1m to 4.6 m elevation, capable of providing a combined flow rate of at least 114 L/min; or

(c) The roof/ceiling protection for rack storage of Category 1, 2 and 3 commodities, stored at heights up to 6.1 m, shall be hydraulically designed to provide the applicable design density, as nominated in table 9.5, over a design area of 186 m^2. (No column sprinklers required.)

NOTE – Building columns with one side of the column flush with the aisle face of the storage array are not considered to be within the array.

Table 9.5 – Steel column sprinkler protection, option 904.4 (c) – Category 1, 2 and 3 commodities (Higher density in lieu of column sprinklers)

Category	Multiple row racks and racks with aisle width less than 2.4 m (mm/min)	Single and double row racks with aisle width 2.4 m or greater (mm/min)
1	15.0	13.5
2	18.0	15.0
3	20.0	17.0
NOTE – Column protection requirements are separately specified for areas where special commodities are stored. See 907.1.2(d) and 907.6.4(d).		

904.5 System drainage

Supplementary drain valves shall be provided at low points of in-rack sprinkler pipework. Drain stop valves shall be plugged and be located not more than 1.8 m above a floor or platform.

905 HYDRAULIC DESIGN REQUIREMENTS

This section applies to EHH systems using standard spray and extra large orifice. Control mode specific application sprinklers also comply with this section unless modified by 908.

905.1 Sizing of pipework

All extra high hazard class sprinkler systems shall be hydraulically designed in accordance with the methods defined within Part 10.

The appropriate sizing of pipework for extra high hazard class sprinkler systems depends on the following factors:

(a) Required design density and design area or listed minimum head pressure and design number of sprinklers required;

(b) Spacing of sprinklers;

(c) Size of sprinkler orifice used;

(d) Pressure and flow characteristics of the water supply.

905.2 Orifice plates

Where it is considered necessary to fit orifice plates in order to assist in hydraulically balancing a system or to meet pump characteristic curves, the diameter of the orifice shall be not less than 50 % of the diameter of the pipe into which the plate is to be fitted. Such orifice plates shall be fitted only in pipes of 50 mm diameter or larger. Orifice plates shall comply with the requirements of Appendix E.

The relationship between the size of the orifice, the flow and the pressure loss, shall be calculated on the basis of the information given in Appendix E.

NOTE – The use of orifice plates as a design practice or for the purposes of balancing the hydraulic characteristics of a sprinkler system, is not recommended.

905.3 Roof/ceiling slope

The design area, for roof/ceiling protection, shall be increased by 30 % where the pitch of the roof/ceiling slope exceeds 10°, for roof slopes up to 20°. This Standard does not provide design solutions for the protection of extra high hazard occupancies with a roof slope exceeding 20 °.

A1 NOTE –
(1) Sawtooth roofs, where the fire plume will be naturally contained, are exempt from this requirement.
(2) This clause does not apply to suppression mode sprinklers. See 518.2.2.

905.4 Hydraulic calculation for mixed hazard classifications

Where two adjacent areas within the same building are protected to requirements of differing design criteria, the effect of one type of protection on the other shall be carefully analysed to ensure that the greatest hydraulic demand on the system is established. Hydraulic analysis shall include moving the boundaries of the design area by one sprinkler along the length of range pipes, progressively, in each direction, until the area of greatest hydraulic demand has been established.

NOTE – This procedure is commonly known as peaking.

Hydraulic calculations shall incorporate the requirements of 904.1.4 (4.6 m extension of higher hazard into lower hazard), and any group of four adjacent sprinklers within this 4.6 m zone which fall within the design area shall discharge at a flow rate appropriate to the higher density.

Regardless of the number and mixture of sprinklers meeting differing design criteria within each of the areas of operation being analysed, the following requirements shall apply:

(a) The design area for each hydraulic analysis shall be the greater of the two occupancy classification design requirements;

(b) Hydraulic calculation methods and the shape of the design area in each hydraulic analysis shall be in accordance with the requirements of Part 10;

(c) The flow rate for any group of four adjacent sprinklers within the design area shall be not less than that required to maintain the minimum density appropriate to the occupancy classification of each of the two adjoining areas.

905.5 Concealed spaces

Where sprinkler protection of concealed spaces is necessary to satisfy the requirements of 207, it shall be hydraulically designed in accordance with the requirements of Part 7.

905.6 Concealed spaces formed of EPS

Should a concealed space (including ducts or plenums) be formed partially or wholly of EPS panel or similar then the requirements of 212 shall apply.

905.7 Sprinklers beneath ducts, cable trays and so on

Where sprinklers are installed beneath obstructions such as ducts, cable trays and conveyors, sprinklers within the design area up to a maximum of four, at the hydraulically most unfavourable location beneath obstructions shall be assumed to be operating simultaneously with the sprinklers at roof or ceiling level. The Standard Spray sprinklers beneath obstructions shall be hydraulically designed to operate at a minimum discharge pressure of 100 kPa, unless a greater pressure is required by the design criteria of the hazard being protected.

905.8 Platforms and mezzanines with solid floors

Solid platforms and mezzanines not more than 2 m wide shall be treated as ducts, cable trays etc. (see 905.7). In the case of walkways between storage fixtures, the requirements of 905.10 shall apply.

Where the area beneath a solid platform or mezzanine greater than 2 m wide is separated from adjoining areas on all sides by a draft curtain, (see 902.9) the flow demand of the sprinklers beneath the platform or mezzanine shall not be required to be added to the flow demand of the sprinklers at roof or ceiling level. However, distribution pipes common to both levels shall be hydraulically sized for the greater of the two hydraulic demands. A clear aisle of 1,200 mm shall be kept centred below the draft curtain.

In all other cases, hydraulic calculations shall be based on simultaneous operation of sprinklers at roof/ceiling level and sprinklers beneath the platform or mezzanine within the design area. Hydraulic design requirements for the sprinklers at each level shall be appropriate to the occupancy classification at that level.

905.9 Non-solid floors (including platforms and mezzanines)

This clause shall apply in situations where sprinklers at more than one elevation may be expected to operate due to fire spread (and water obstruction) from one level to other levels through non-solid floors such as grated or slatted platforms and mezzanines, (see 905.10 for solid and non-solid walkways between storage fixtures).

905.9.1 *Design constraints*

The requirements of 905.9 are subject to the following design constraints:

(a) Occupancies above and below a non-solid floor shall be the same, either both Storage or Process areas, except that a combination of extra high hazard process occupancy and ordinary hazard classification areas is acceptable;

(b) Where rack, shelf or bin box storage exists above or below a non-solid floor, the storage structures at one level shall run parallel to the storage structures at the level above or below;

(c) The total storage height (from base floor to top of storage at uppermost level) of solid pile, palletised, shelf or bin box storage, shall not exceed the height limits nominated in tables 9.11(a) to 9.11(e), as appropriate.

Where compliance with the above requirements is not possible, it shall be necessary to cover the non-solid floor with a solid deck and to apply the requirements of 905.8.

905.9.2 *Design requirements – General*

The following general design requirements shall apply for non-solid floors:

(a) Areas above and below non-solid floors shall be treated as one combined fire area;

(b) The total storage height shall be taken as the distance from the base of storage at the lowest level, to the top of storage at the uppermost level;

(c) Sprinklers installed beneath the non-solid floor shall be in-rack sprinklers as described in 904.2.1, fitted with a water shield;

(d) The general design and hydraulic design requirements of 904 and 905 shall apply, unless otherwise required by this section.

905.9.3 *Design requirements – Process occupancies*

The following design requirements shall apply for process occupancy areas with non-solid floors:

(a) The design criteria for roof/ceiling sprinklers shall be in accordance with the requirements of 904 and 905 and table 9.7, based on the highest hazard occupancy present, above or below the non-solid floor;

(b) The design criteria for sprinklers below non-solid floors shall be based upon eight (8) operating sprinklers flowing 84 L/min each for ordinary hazard or 114 L/min each for extra high hazard process occupancies;

(c) Sprinklers below non-solid floors shall be in-rack sprinklers, (see 905.9.2(c)) with a maximum area per sprinkler of 12 m^2, and a maximum spacing of 3.7 m;

(d) Hydraulic calculations shall be based on roof/ceiling sprinklers and sprinklers beneath non-solid floors operating simultaneously.

905.9.4 *Design requirements – Solid pile, palletised, shelf and bin box storage*

The following design requirements shall apply for solid pile, palletised, shelf and bin box storage areas with non-solid floors:

(a) Where the longitudinal faces of shelf and bin box storage structures at one level are vertically aligned with those above and below non-solid floors throughout the design area, the requirements of 905.10.2 shall apply as an alternative to this clause;

(b) The design criteria for roof/ceiling sprinklers shall be in accordance with the requirements of 904 and 905 and table 9.11(a) to (e), as appropriate, based on the total storage height, (see 905.9.2(b)) and the highest category of storage present, above or below the non-solid floor;

(c) The design criteria for sprinklers below each non-solid floor shall be in accordance with the requirements of table 9.6, based on the highest category of storage present below each non-solid floor;

(d) Sprinklers below non-solid floors shall be in-rack sprinklers, (see 905.9.2(c)), with a maximum area per sprinkler of 9 m^2, and a maximum spacing of 3.7 m;

(e) Hydraulic calculations shall be based on roof/ceiling sprinklers and sprinklers beneath non-solid floors operating simultaneously.

Table 9.6 – Water demands for sprinklers under non-solid floors; solid-piled, palletised, shelf and bin box storage

Category	**Demand for sprinklers under non-solid floors**	
	No. of operating sprinklers	**Minimum discharge rate per sprinkler** (L/min)
1 to 3	6	84
4	8	84
5 and 6	8	114

905.9.5 *Design requirements – Rack storage*

The following design requirements for rack storage areas with non-solid floors shall apply:

(a) For total storage heights, (see 905.9.2(b)) not greater than 7.6 m, the design criteria for roof/ceiling sprinklers, and the number of levels of in-rack sprinklers required, shall be in accordance with the requirements of tables 9.12(a) to (r), as appropriate. Horizontal and vertical spacing of in-rack sprinklers shall be in accordance with the requirements of 904.2.4 and 904.2.5;

(b) For total storage heights (see 905.9.2(b)) greater than 7.6 m, the design criteria for roof/ceiling sprinklers, and the number of levels, horizontal spacing and vertical spacing of in-rack sprinklers, shall be in accordance with the requirements of tables 9.13(a) to (f), as appropriate;

(c) In determining the design criteria from the foregoing tables, each aisle width shall be taken as the least continuous clear space present, from the base of storage at the lowest level, up to the top of storage at the uppermost level (see 'clear aisle' examples 1 and 2 in figure 9.18(a));

(d) Hydraulic design requirements for in-rack sprinklers shall be in accordance with 905.12.2;

(e) When one of the required number of levels of in-rack sprinklers can be located directly beneath the non-solid floor without exceeding the vertical spacing limitations for in-rack sprinklers, the sprinklers beneath the non-solid floor may be considered as one level of in-rack sprinklers, and shall be installed as follows:

   (i) The design criteria shall be the same as for in-rack sprinklers

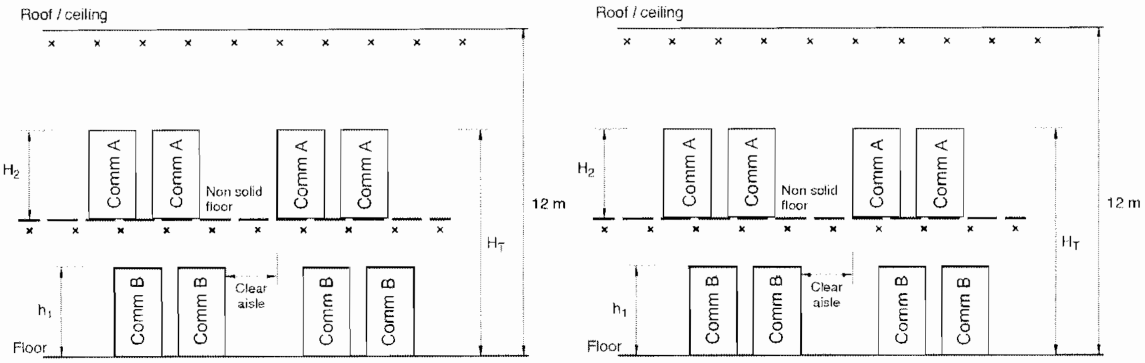
   (ii) For single-row racks the sprinklers shall be located longitudinally along the centre of each rack

   (iii) For double-row racks the sprinklers shall be located as shown in figure 9.18(b)

   (iv) For multiple-row racks the sprinklers shall be located as shown in figure 9.18(c).

   Hydraulic calculations shall be based on roof/ceiling sprinklers and in-rack sprinklers (including the sprinklers directly beneath the non-solid floor) operating simultaneously, as necessary to satisfy the requirements of 905.12.2;

(f) When one of the required number of levels of in-rack sprinklers cannot be located directly beneath the non-solid floor without exceeding the vertical spacing limitations for in-rack sprinklers, an additional level of in-rack sprinklers shall be installed beneath the non-solid floor. The design criteria for the additional level of in-rack sprinklers shall be the same as for other in-rack sprinklers. Hydraulic calculations shall be based on roof/ceiling sprinklers and in-rack sprinklers (excluding the sprinklers directly beneath the non-solid floor) operating simultaneously in accordance with the requirements of 905.12.2.



Example 1

Comm. A = commodity Category 2

Comm. B = commodity Category 3
(table 9.12(g), 1 level IRS)

H_T = 6.1 m
h_1 = 2.4 m
H_2 = 3.0 m
Clear aisle = 1.6 m
Total water demand = Roof/ceiling sprinklers + sprinklers under non-solid floor
Roof/ceiling demand = 11.5 mm/min/186 m^2 with 141 °C sprinklers (see table 9.12(g))
Sprinklers under non-solid floor = 6 sprinklers, each discharging 84 L/min (see table 9.6)
Total water demand = 2,140 + 505 L/min [4]

Example 2

Comm. A = commodity Category 5
(table 9.12(m), 2 levels IRS)
Comm. B = commodity Category 3

H_T = 6.7 m
h_1 = 3.0 m
H_2 = 3.0 m
Clear aisle = 1.8 m
Total water demand = Roof/ceiling sprinklers + Rack
Roof/ceiling demand = 12 mm/min/186 m^2 with 141 °C sprinklers (see table 9.12(m))
Rack demand [2] = 14 sprinklers, each discharging 114 L/min (see table 9.6)
Total water demand = 2,235 + 1,600 L/min [4]

NOTE –

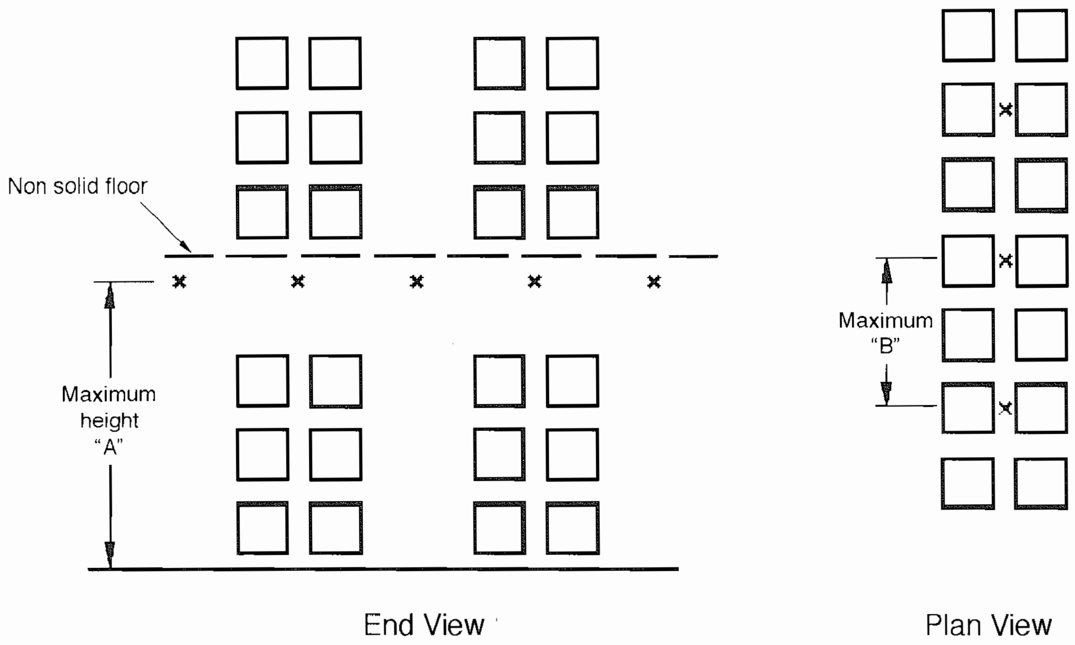
(1) In Example 1, table 9.4 establishes that the sprinklers beneath the non-solid floor are deemed to be one level of IRS. They are to be installed in accordance with figure 9.18(b) (in the case of MRR figure 9.18(c) would apply).

(2) In Example 2, neither of the 2 levels of IRS, required by table 9.12(m), can be located beneath the non-solid floor without exceeding the vertical spacing requirements of table 9.4. Therefore 905.9.5(f) applies, resulting in the requirement for sprinklers beneath the non-solid floor as well as the 2 levels of IRS. They are to be installed in accordance with figure 9.18(b) (in the case of MRR figure 9.18(c) would apply).

(3) In Example 2, the rack demand shall also be available under the non-solid floor, but not simultaneously with the rack demand (see 905.9.5(f)).

(4) Water demands given above are theoretical minimum rates only. The actual flow rates will be greater due to wastage as pressure increases at sprinklers due to friction losses in pipework.

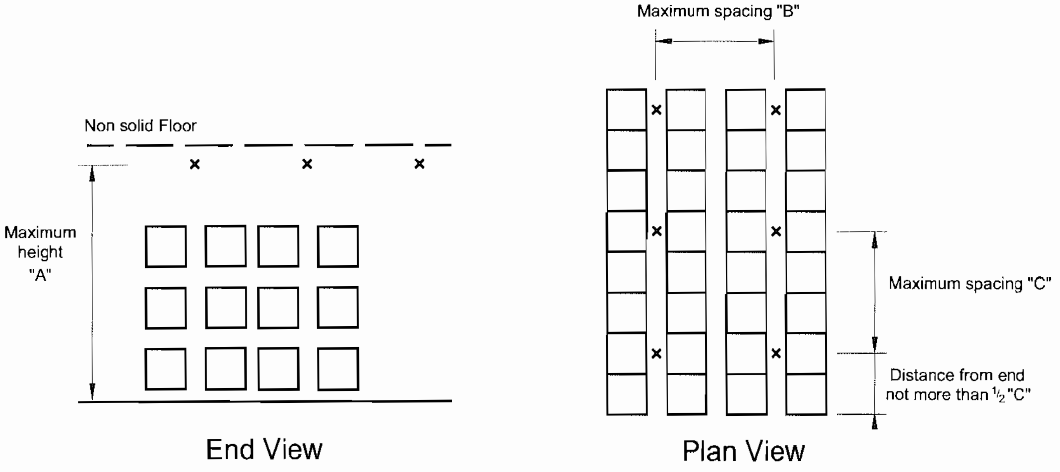
Figure 9.18(a) – Design examples for rack storage on a non-solid floor structure showing clear aisle



For Categorised Commodities (see 906)

Dimensions "A" and "B" see:
904.2.4 Horizontal spacing – Storage height up to 7.6 m
904.2.5 Vertical spacing – Storage height up to 7.6 m
904.2.6 Horizontal and vertical spacing – Storage height greater than 7.6 m

Figure 9.18(b) – Design examples for double row rack storage under a non-solid floor structure to be considered as one level of in-rack sprinklers



For Categorised Commodities (see 906)

Dimensions "A", "B" and "C" see
904.2.4 Horizontal spacing – Storage height up to 7.6 m
904.2.5 Vertical spacing – Storage height up to 7.6 m
904.2.6 Horizontal and vertical spacing – Storage height greater than 7.6 m

Figure 9.18(c) – Design examples for multiple row rack storage under a non-solid floor structure under non-solid floor structure to be considered as one level of in-rack sprinklers

905.10 Walkways (Solid and non-solid)

905.10.1 *Rack storage*

Where any walkways are installed between racks, the roof/ceiling and in-rack sprinkler design requirements shall be determined as if the walkway does not exist.

The flow demand for sprinklers beneath the walkway shall be in accordance with the requirements of table 9.6 as applied to sprinklers beneath a non-solid floor, and shall be based on the highest category of commodity being stored. However, when sprinklers are installed in racks, the sprinklers beneath the walkway shall meet the same criteria as the in-rack sprinklers. The flow demand for the in-rack sprinklers shall not be required to be added to the flow demand for sprinklers under the walkways, however, total design area demand shall include the greater of the two flow demands.

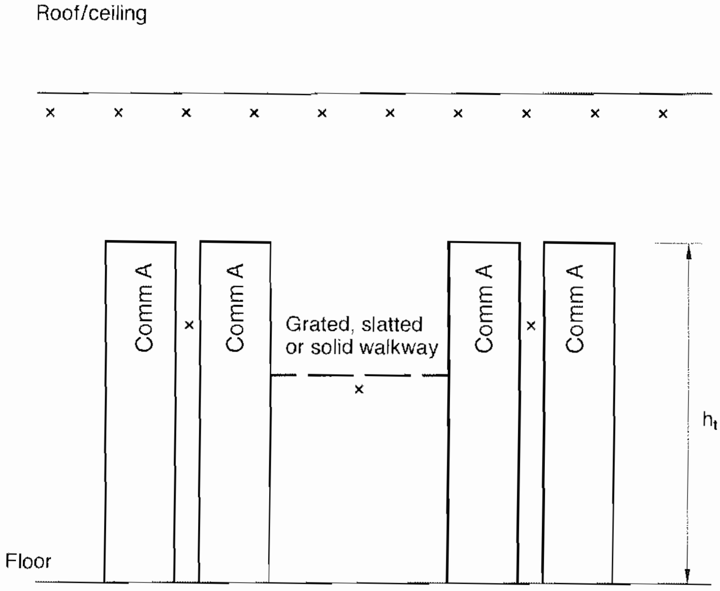
Sprinklers under walkways between rack storage can be considered as one level of in-rack sprinklers when they are:

(a) Within 460 mm of the face of racks;

(b) In line with at least every alternate transverse flue;

(c) Horizontal and vertical spacings do not exceed the maximum spacing nominated in 904.2 for in-rack sprinklers.

See figure 9.19 for an example of the application of these requirements.



h_t = 7.6 m
Comm. A = commodity Category 4
Without solid shelves
Clear aisle = 1.2 m
Floor to ceiling height = 13.5 m
Total water demand = roof/ceiling + rack demand
Roof/ceiling demand = 16 mm/min/186 m^2 (table 9.12(j))
Rack demand[1] = 8 sprinklers, each discharging 84 L/min (table 9.9)
Total water demand = 2975 + 675 = 3650 L/min[2]

NOTE –

(1) This demand should also be available from the sprinklers under the walkway, but not simultaneously with the rack demand.

(2) Total water demands given above are theoretical minimum rates only. The actual flow rates will be greater due to wastage as pressure increases at the sprinkler due to friction losses in pipework.

Figure 9.19 – Design example for rack storage with grated, slatted or solid walkway

905.10.2 *Shelf and bin box storage*

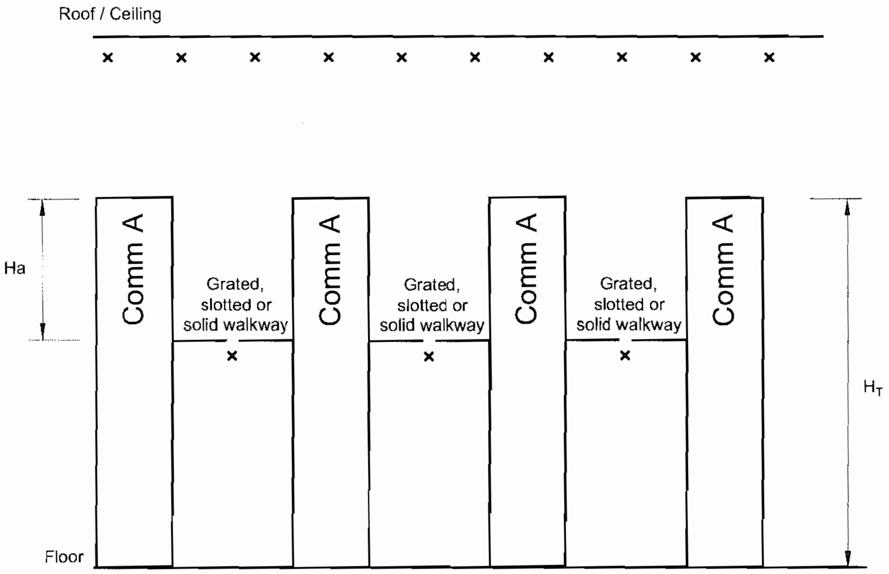
The design criteria for sprinklers at roof/ceiling level over shelf and bin box storage, shall be in accordance with the requirements of 904 and 905, based on the height of storage above the walkway and on the highest category of commodity being stored.

The height of storage above the walkway shall be limited to 4.6 m.

The design criteria for sprinklers beneath walkways shall be in accordance with the requirements of 904 and 905 for in-rack sprinklers.

Design area demand calculations shall be based on the assumption that sprinklers at roof/ceiling level and sprinklers beneath walkways are operating simultaneously.

See figure 9.20 for an example of the application of these requirements.


Roof / Ceiling
Ha
Comm A
Grated, slotted or solid walkway
Comm A
Grated, slotted or solid walkway
Comm A
Grated, slotted or solid walkway
Comm A
H_T
Floor

H_T = 6.1 m

Comm. A = commodity Category 4

H_a[1] = 2.4 m

Floor to ceiling height = 12.0 m

Aisle = 1.1 m

Total water demand = roof/ceiling sprinklers + sprinklers under walkway

Roof/ceiling demand = 7 mm/min/186 m^2 (table 9.11(a))

Sprinklers under walkway demand = 8 sprinklers, each discharging 84 L/min, (table 9.9)

Spacing between sprinklers under walkway is 3.1 or 3.7 m maximum (table 9.3)

Total water demand = 1,300 + 675 L/min [2]

NOTE –

(1) Shelf storage of Category 1 to 6 commodities is limited to 4.6 m high above walkway.

(2) Total water demands given above are theoretical minimum rates only. The actual flow rates will be greater due to wastage as pressure increases at sprinklers due to friction losses in pipework.

Figure 9.20 – Design example for bin box and shelf storage with grated, slatted or solid walkway

905.11 Process occupancies

For extra high hazard process occupancies, design densities and design areas shall be as given in table 9.7.

General design requirements (i.e. type, temperature rating, area coverage and spacing) for roof/ceiling level sprinklers, shall be in accordance with 904.1.1 to 904.1.6.

Table 9.7 – Design density and design area for process occupancies

Occupancy	**Design density,** (mm/min)	**Design area** (m^2)
Aircraft engine testing	10.0	260
Aircraft hangars [1]	7.5	Zone protection (deluge system)
Celluloid manufacturers and celluloid goods manufacturers	12.5	260
Coal fired energy plants	10.0	260
Distilleries (still houses)	12.0	260
Electrical/electronic manufacturing and assembly (predominantly plastic components)	7.5	260
Exhibition halls with unusually high ceilings and high concentration of combustibles	12.0	360
Firelighter manufacturers [2]	10.0	260
Firework manufacturers	10.0	Complete deluge protection required for each building
Flammable liquid spraying	12.0	260
Floor cloth and linoleum manufacturers	7.5	260
Foam plastics goods manufacturers and processing	12.0	260
Foam rubber goods manufacturers and processing	12.0	260
LPG bulk storage tanks	10.0	Entire exterior of tank
Paint and varnish works (solvent based) [2]	7.5	260
Plastics goods manufacturing and process works (where plastic is one of the basic materials in the operation)	12.0	260
Resin and turpentine manufacturers [2]	7.5	260
Theatrical scenery store	10.0	260
Tar distillers [2]	10.0	260
Heavy vehicle repair workshops	10.0	260

NOTE –

(1) A suitable alternative design approach to the protection of aircraft hangars is provided in ANSI/NFPA 409.

(2) Supplementary protection by high or medium velocity sprayers, as appropriate, will be required in these occupancies in areas where solvents or other flammable liquids are stored or handled (see 203.5).

905.12 Storage occupancies

905.12.1 *Roof/ceiling sprinklers*

Design densities and design areas for roof/ceiling sprinklers shall be in accordance with tables 9.11(a) to (e), tables 9.12(a) to (r) and tables 9.13(a) to (f) as appropriate.

See 906.1 and the design decision tree, (figure 9.22) for guidance in the selection of an appropriate table and figure.

General design requirements (i.e. type, temperature rating, area coverage and spacing) for roof/ceiling level sprinklers, shall be in accordance with 904.1.1 to 904.1.6.

Roof/ceiling sprinkler design density adjustments, in accordance with the requirements of table 9.8, are permissible after all other necessary adjustments have been made.

Table 9.8 – Roof/ceiling sprinkler design density adjustments

In-rack sprinkler levels	Roof/ceiling sprinkler design density adjustment
None	None
One level, when none needed.	When the design table gives options for either 'roof/ceiling sprinklers only' or for 'roof/ceiling plus in-rack sprinklers', use the roof/ceiling design density for the 'roof/ceiling plus in-rack sprinklers' entry. When the only option is 'roof/ceiling only' sprinklers, the design density may be reduced by 20 %.
More than one level when none needed, or more than one level when one needed.	Reduce the design density by 20 % from that applicable to one level of in-rack sprinklers.
More than two levels when two levels needed.	Reduce the design density by 20 % from that applicable to two levels of in-rack sprinklers.
Sprinkler levels spaced vertically, at intervals between 1.1 m and 1.8 m, when the applicable design requirements specify a greater vertical spacing.	Reduce the design density by 40 % from that applicable to the minimum number of required levels of in-rack sprinklers.

905.12.2 *In-rack sprinklers*

In-rack sprinkler pipework shall be hydraulically designed to provide the nominated minimum discharge rate from each of the nominated number of sprinklers operating simultaneously at the hydraulically most unfavourable location within the design area, in accordance with the requirements of table 9.9.

Where more than one level of in-rack sprinklers is installed, the nominated number of operating sprinklers from table 9.9, shall be assumed to be operating at each of the two hydraulically most unfavourable adjacent levels.

Where more than one row of in-rack sprinklers is installed at a level, the nominated number of operating sprinklers from table 9.9 shall be assumed to operating in the hydraulically most unfavourable arrangement of up to three rows of in-rack sprinklers at each level. For example if 6 heads are nominated in table 9.9 then hydraulic calculations shall check 1 row of 6 heads, 2 rows of 3 heads and 3 rows of 2 heads to determine the most unfavourable demand.

In the sizing of distribution pipework, the water flow required by the in-rack sprinklers shall be added to that required by the roof/ceiling sprinklers and sprinklers protecting building columns, (see 904.4). At the points where the in-rack pipework meets the roof/ceiling pipework, the respective flows shall be balanced in accordance with Part 10.

General design requirements (i.e. type, temperature rating, area coverage and spacing) for in-rack sprinklers, shall be in accordance with 904.2.1 to 904.2.8.

Other in-rack sprinkler design and installation requirements for Categorised Commodities shall be in accordance with tables 9.12(a) to (r); and tables 9.13(a) to (f) as appropriate (also see design decision tree figure 9.22 for guidance in selection of appropriate tables).

In general these requirements also apply to Special Commodities (see 907), however some aspects of the design requirements may differ.

Table 9.9 – Minimum in-rack sprinkler hydraulic design criteria

Category	**Number of levels of in-rack sprinklers**	**Total number of sprinklers**	**Storage height up to 7.6 m**	**Storage height greater than 7.6 m**
			Min. sprinkler discharge rate (L/min)	**Min. sprinkler discharge rate** (L/min)
1, 2 and 3	1	6	84	114
	2 or more	5 on 2 levels		
4	1	8	84	
	2 or more	7 on 2 levels		
5 and 6	1	8	114	
	2 or more	7 on 2 levels		

905.12.3 *Concealed space sprinklers*

Should a concealed space (including ducts or plenums) be formed partially or wholly of EPS panel or similar then the requirements of 212 shall apply.

905.12.4 *Excessive clearance – Categorised commodities*

Where the clearance between roof/ceiling sprinklers and the top of rack storage exceeds 6.1 m, one of the following four options shall be applied:

(a) Sprinkler protection shall be provided that complies with the requirements of this section for a storage height that would correspond to a maximum clearance. (For example, if storage is 4.6 m high in a 12.2 m high building, sprinkler protection shall satisfy the requirements for a 6.1 m high storage);

(b) A suspended ceiling shall be installed, at least 1 m above the top of the storage and above the aisles between storage, with sprinklers installed beneath the suspended ceiling. The design criteria for the sprinklers beneath the suspended ceiling shall be in accordance with the requirements of 905.12.1.

NOTE – Suspended ceilings should be of substantial construction, capable of withstanding temperatures above 550 °C for up to 10 minutes, and uplift velocity pressures of at least 0.14 kPa.

Concealed spaces above suspended ceilings should be protected in accordance with the requirements of 207. In the sizing of distribution pipework, the water flow required for concealed space sprinklers is not required to be added to that required for the sprinklers beneath the suspended ceiling;

(c) In the case of rack storage, a line of in-rack sprinklers shall be installed 900 mm to 1500 mm above the top of the rack storage, designed in accordance with the requirements of 905.12.2 (see figure 9.21). Roof/ceiling sprinkler protection shall be the same as for racks without solid shelves and with a clearance not exceeding 6.1 m; or

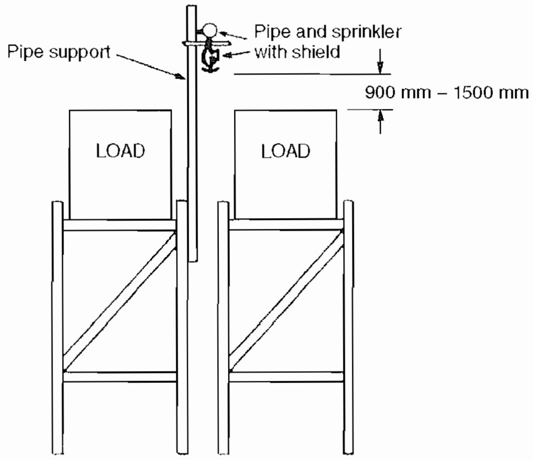


Figure 9.21 – Optional arrangement for all categorised commodities with clearance greater than 6.1 m

(d) A horizontal barrier (see 902.17), extending to the full length and width of storage within each rack shall be installed 1 m to 1.5 m above the top of the storage, with in-rack sprinklers installed beneath the barriers designed in accordance with the requirements of 905.12.2. These sprinklers do not require shields. In addition, the sprinklers at roof/ceiling level shall be hydraulically designed to satisfy the minimum design criteria specified in table 9.10. Hydraulic calculations shall incorporate the flow and pressure requirements for roof/ceiling sprinklers and sprinklers beneath barriers operating concurrently.

Table 9.10 – Minimum roof/ceiling sprinklers hydraulic design criteria for excessive clearance

Category	Design density (mm/min)	Design area (m^2)
1	6.1	186
2 to 6 inclusive	8.2	186

905.12.5 *Excessive clearance – Special commodities*

Where the clearance between roof-ceiling sprinklers and the top of storage exceeds the maximum clearance nominated for the particular Special Commodity storage configuration, sprinkler protection shall be provided that complies with the design requirements for a storage height which would correspond to a maximum clearance. (For example, if the maximum clearance nominated is 3 m, and storage is 5 m high in a 9 m high building, sprinkler protection shall satisfy the requirements for a 6 m storage height.)

Where this design alternative cannot be applied, a suspended ceiling shall be installed, at least 1 m above the top of the storage and above the aisles between storage, with sprinklers installed beneath the suspended ceiling. The design criteria for the sprinklers beneath the suspended ceiling shall be in accordance with the requirements specified for the particular commodity.

NOTE – Suspended ceilings should be of substantial construction, capable of withstanding temperatures above 550 °C for up to 10 minutes, and uplift velocity pressures of at least 0.14 kPa.

Concealed spaces above suspended ceilings should be protected in accordance with the requirements of 207. In the sizing of distribution pipework, the water flow required for concealed space sprinklers is not required to be added to that required for the sprinklers beneath the suspended ceiling.

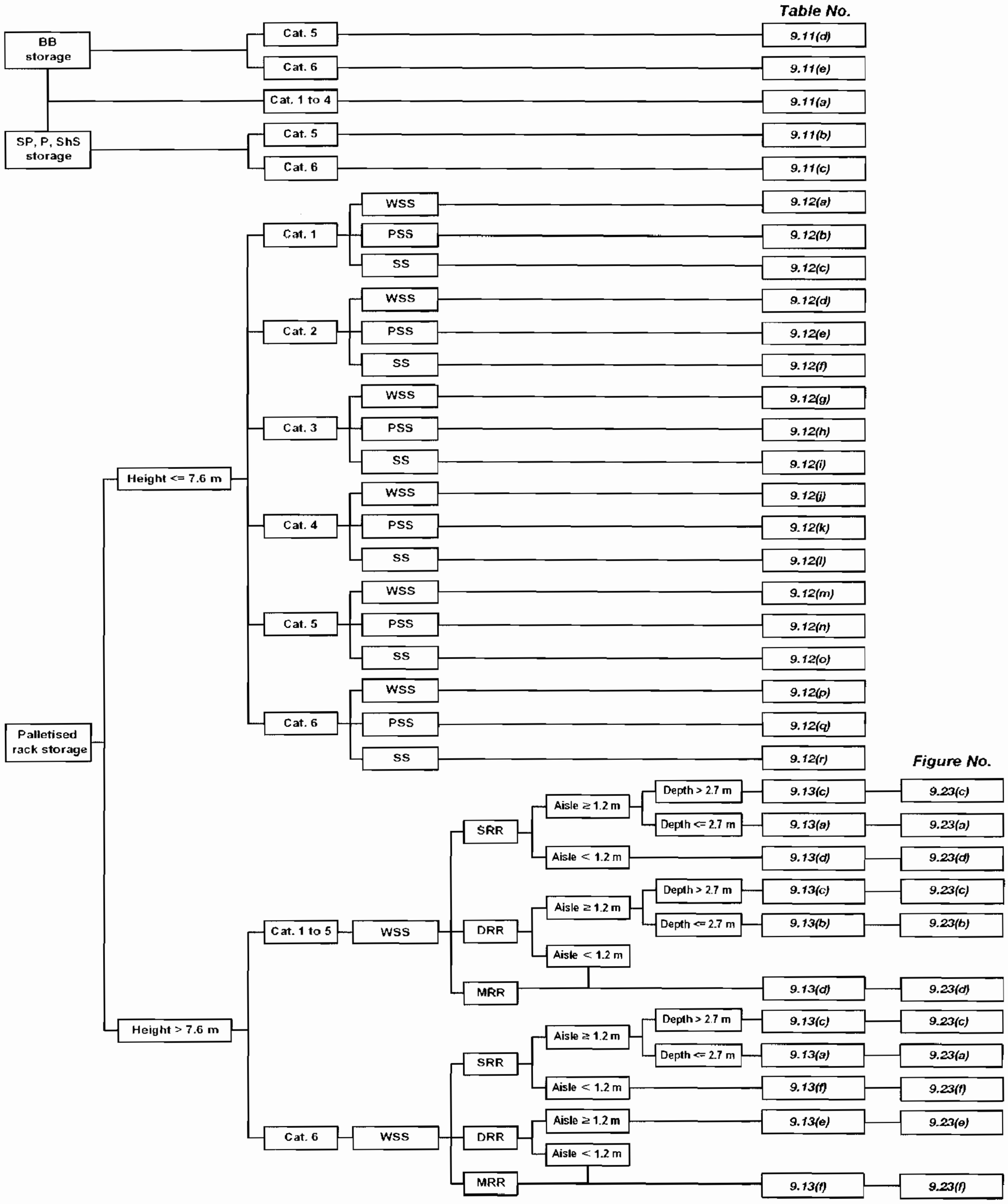
906 CATEGORISED COMMODITIES

This section specifies the requirements and procedures for the design of standard sprinkler system protection for commodities that can be categorised by their occupancy classification (see Appendix B).

For protection of Special Commodities see 907.

906.1 Design decision trees for categorised commodities

The design decision tree in figure 9.22 is provided for general guidance in selecting the appropriate level of protection for high piled storage of categorised commodities, but should be used with particular consideration of Appendix B. Alternative design approaches using control mode specific application and suppression mode Sprinklers are provided in 908 and 909.



KEY –

BB – Bin box
SP – Solid pile
P – Palletised
ShS – Shelf
WSS – Without solid shelves
PSS – Partial solid shelves (1.9 m^2 to 5.9 m^2)
SS – Solid shelves (> 5.9 m^2)
SRR – Single row rack
DRR – Double row rack
MRR – Multiple row rack

Figure 9.22 – Categorised commodities design decision tree

906.2 Solid pile, palletised, shelf and bin box storage

Categorised Commodities for solid pile, palletised, shelf and bin box storage, shall be in accordance with tables 9.11(a) to (e).

Table 9.11(a) – Design criteria for categories 1 to 4: Solid pile, palletised, shelf and bin box storage

Storage height (m)	**Category**			
	rDD, mm/min			
	1	**2**	**3**	**4**
4.6	6.0	6.0	6.0	7.0
4.8	6.0	6.0	6.5	7.5
5.0	6.0	6.5	7.0	8.0
5.2	6.0	6.5	7.0	8.5
5.4	6.0	6.5	7.5	9.0
5.6	6.0	6.5	8.0	9.5
5.8	6.0	7.0	8.5	10.0
6.0	6.0	7.0	9.0	10.5
6.2	6.0	7.0	9.0	11.5
6.4	6.5	7.5	9.5	12.0
6.6	7.0	8.0	10.0	12.5
6.8	7.5	8.5	10.5	13.5
7.0	8.0	9.0	11.0	14.0
7.2	8.0	9.0	11.0	14.5
7.4	8.5	9.5	11.5	15.5
7.6	9.0	10.0	12.0	16.0
7.8	9.5	10.5	12.5	17.0
8.0	10.0	11.0	13.5	18.0
8.2	10.0	11.5	14.0	19.0
8.4	10.5	12.0	14.5	19.5
8.6	11.0	12.5	15.5	20.5
8.8	11.5	13.0	16.0	21.5
9.0	12.0	13.5	16.5	22.5
9.2	n/p			
9.4	n/p			
9.6	n/p			
9.8	n/p			
10.0	n/p			
10.2	n/p			
10.4	n/p			
10.6	n/p			
10.7	n/p			

Table 9.11(a) design constraints

The requirements of this table shall apply, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) A design area of 186 m^2 at roof/ceiling level (see table entry notation 1).

(iii) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1 and 2).

(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(vi) Shelf storage as defined in 902.36.

(vii) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.11(a) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. n/p – not permitted.

Table 9.11(b) – Design criteria for category 5: Solid pile, palletised and shelf storage

Maximum storage height (m)	Maximum roof/ceiling height											
	Up to 4.6 m		4.7 to 6.1 m		6.2 to 7.6 m		7.7 to 9.1 m		9.2 to 10.7 m		10.8 to 12.2 m	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
1.5	8.0	232	12.0	186	12.0	186	(Note 2)		(Note 2)		(Note 2)	
1.6	8.0	232	12.0	188	12.5	189	18.0	232 (Note 2)	(Note 2)		(Note 2)	
1.8	8.0	232	12.5	191	13.0	195	18.0	232 (Note 2)	(Note 2)		(Note 2)	
2.0	8.0	232	13.0	194	14.0	201	18.0	232 (Note 2)	(Note 2)		(Note 2)	
2.2	8.0	232	13.5	197	14.5	207	18.0	232 (Note 2)	(Note 2)		(Note 2)	
2.4	8.0	232	13.5	200	15.5	214	18.0	232 (Note 2)	(Note 2)		(Note 2)	
2.6	8.0	232	14.0	203	16.5	220	18.0	232 (Note 2)	(Note 2)		(Note 2)	
2.8	8.0	232	14.5	206	17.0	226	18.0	232 (Note 2)	(Note 2)		(Note 2)	
3.0	8.0	232	15.0	209	18.0	232	18.0	232 (Note 2)	(Note 2)		(Note 2)	
3.2	15.5	211	15.5	211	18.5	235	18.5	235	24.0	280 (Note 2)	(Note 2)	(Note 2)
3.4	15.5	214	15.5	214	19.0	242	19.0	242	24.0	280 (Note 2)	(Note 2)	(Note 2)
3.6	16.0	217	16.0	217	20.0	248	20.0	248	24.0	280 (Note 2)	(Note 2)	(Note 2)
3.8	n/p		16.5	220	21.0	255	21.0	255	24.0	280 (Note 2)	(Note 2)	
4.0	n/p		17.0	223	21.5	261	21.5	261	24.0	280 (Note 2)	(Note 2)	(Note 2)
4.2	n/p		17.0	226	22.5	267	22.5	267	24.0	280 (Note 2)	(Note 2)	(Note 2)
4.4	n/p		17.5	229	23.0	274	23.0	274	24.0	280 (Note 2)	(Note 2)	(Note 2)
4.6	n/p		18.0	232	24.0	280	24.0	280	24.0	280	(Note 2)	(Note 2)
4.8	n/p		24.0	280	24.0	280	24.0	280	n/p			
5.0	n/p		24.0	280	24.0	280	24.0	280	n/p			
5.2	n/p				24.0	280	24.0	280	n/p			
5.4	n/p				24.0	280	24.0	280	n/p			
5.6	n/p				24.0	280	24.0	280	n/p			
5.8	n/p				24.0	280	24.0	280	n/p			
6.0	n/p				24.0	280	24.0	280	n/p			
6.1	n/p				24.0	280	24.0	280	n/p			

Table 9.11(b) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).
(ii) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1 and 3).
(iii) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(iv) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(v) Shelf storage as defined in 902.36.
(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vii) Roof/ceiling slope up to 1 in 6 (10.0°) (see table entry notation 3).

Table 9.11(b) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the design area by 1.3 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10.0°), multiply the design area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. rDA – Roof/ceiling design area, m^2.
9. n/p – not permitted.

Table 9.11(c) – Design criteria for category 6: Solid pile, palletised and shelf storage

Maximum storage height (m)	Maximum roof/ceiling height											
	Up to 4.6 m		4.7 to 6.1 m		6.2 to 7.6 m		7.7 to 9.1 m		9.2 to 10.7 m		10.8 to 12.2 m	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
1.50	12.0	186	12.0	186	12.0	186	(Note 2)		(Note 2)		(Note 2)	
1.60	13.0	188	13.0	192	13.0	192	24.0	280 (Note 2)	(Note 2)		(Note 2)	
1.80	14.5	191	14.5	204	14.5	204	24.0	280 (Note 2)	(Note 2)		(Note 2)	
2.00	16.0	194	16.0	216	16.0	216	24.0	280 (Note 2)	(Note 2)		(Note 2)	
2.20	17.5	197	17.5	227	17.5	227	24.0	280 (Note 2)	(Note 2)		(Note 2)	
2.40	19.0	200	19.0	239	19.0	239	24.0	280 (Note 2)	(Note 2)		(Note 2)	
2.60	20.5	203	20.5	251	20.5	251	24.0	280 (Note 2)	(Note 2)		(Note 2)	
2.80	22.0	206	22.0	263	22.0	263	24.0	280 (Note 2)	(Note 2)		(Note 2)	
3.00	23.5	209	23.5	274	23.5	274	24.0	280 (Note 2)	(Note 2)		(Note 2)	
3.20	24.0	285	24.0	285	24.0	293	24.0	293	24.0	465 (Note 2)	(Note 2)	(Note 2)
3.40	24.0	294	24.0	294	24.0	317	24.0	317	24.0	465 (Note 2)	(Note 2)	(Note 2)
3.60	24.0	303	24.0	303	24.0	342	24.0	342	24.0	465 (Note 2)	(Note 2)	(Note 2)
3.80	n/p		24.0	312	24.0	367	24.0	367	24.0	465 (Note 2)	(Note 2)	
4.00	n/p		24.0	321	24.0	391	24.0	391	24.0	465 (Note 2)	(Note 2)	(Note 2)
4.20	n/p		24.0	330	24.0	416	24.0	416	24.0	465 (Note 2)	(Note 2)	(Note 2)
4.40	n/p		24.0	339	24.0	441	24.0	441	24.0	465 (Note 2)	(Note 2)	(Note 2)
4.60	n/p		24.0	348	24.0	465	24.0	465	24.0	465	(Note 2)	(Note 2)

Table 9.11(c) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).
(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(iii) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1 and 3).
(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(v) Shelf storage as defined in 902.36.
(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.11(c) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the design area by 1.3 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. rDA – Roof/ceiling design area, m^2.
9. n/p – not permitted.

Table 9.11(d) – Design criteria for category 5: Bin box storage

Maximum storage height (m)	Maximum roof/ceiling height											
	Up to 4.6 m		4.7 to 6.1 m		6.2 to 7.6 m		7.7 to 9.1 m		9.2 to 10.7 m		10.8 to 12.2 m	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
1.50	8.0	232	12.0	186	12.0	186	(Note 2)		(Note 2)		(Note 2)	
1.60	8.0	232	12.0	189	12.0	189	12.0	232 (Note 2)	(Note 2)		(Note 2)	
1.80	8.0	232	12.0	195	12.0	195	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.00	8.0	232	12.0	201	12.0	201	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.20	8.0	232	12.0	206	12.0	206	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.40	8.0	232	12.0	212	12.0	212	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.60	8.0	232	12.0	218	12.0	218	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.80	8.0	232	12.0	224	12.0	224	12.0	232 (Note 2)	(Note 2)		(Note 2)	
3.00	8.0	232	12.0	229	12.0	229	12.0	232 (Note 2)	(Note 2)		(Note 2)	
3.20	12.5	229	12.5	229	12.5	232	12.5	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
3.40	13.0	223	13.0	223	13.0	232	13.0	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
3.60	14.0	217	14.0	217	14.0	232	14.0	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
3.80	n/p		15.0	211	15.0	232	15.0	232	18.0	232 (Note 2)	(Note 2)	
4.00	n/p		15.5	205	15.5	232	15.5	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
4.20	n/p		16.5	199	16.5	232	16.5	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
4.40	n/p		17.0	192	17.0	232	17.0	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
4.60	n/p		18.0	186	18.0	232	18.0	232	18.0	232	(Note 2)	(Note 2)
4.80	n/p		18.0	232	18.0	232	18.8	232	18.8	232	24.0	232 (Note 2)
5.00	n/p		18.0	232	18.0	232	19.6	232	19.6	232	24.0	232 (Note 2)
5.20	n/p				18.0	232	20.4	232	20.4	232	24.0	232 (Note 2)
5.40	n/p				18.0	232	21.2	232	21.2	232	24.0	232 (Note 2)
5.60	n/p				18.0	232	22.0	232	22.0	232	24.0	232 (Note 2)
5.80	n/p				18.0	232	22.8	232	22.8	232	24.0	232 (Note 2)

Table 9.11(d) – Design criteria for category 5: Bin box storage (continued)

Maximum storage height (m)	Maximum roof/ceiling height											
	Up to 4.6 m		4.7 to 6.1 m		6.2 to 7.6 m		7.7 to 9.1 m		9.2 to 10.7 m		10.8 to 12.2 m	
	rDD	**rDA**	**rDD**	**rDA**	**rDD**	**rDA**	**rDD**	**rDA**	**rDD**	**rDA**	**rDD**	**rDA**
6.00	n/p				18.0	232	23.6	23.6	232	24.0	232 (Note 2)	
6.20	n/p				24.0	232	24.0	232	n/p			
6.40	n/p				24.0	232	24.0	232	n/p			
6.60	n/p				24.0	232	24.0	232	n/p			
6.80	n/p						24.0	232	n/p			
7.00	n/p						24.0	232	n/p			
7.20	n/p						24.0	232	n/p			
7.40	n/p						24.0	232	n/p			
7.60	n/p						24.0	232	n/p			

Table 9.11(d) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for, dry or pre-action systems (see 903.2).

(iii) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1 and 3).

(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vi) Roof/ceiling slope up to 1 in 6 (10°). (see table entry notation 3).

Table 9.11(d) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the design area by 1.3 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10 degrees), multiply the design area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. rDA – Roof/ceiling design area, m^2.
9. n/p – not permitted.

Table 9.11(e) – Design criteria for category 6: Bin box storage

Max. storage height (m)	Maximum roof/ceiling height											
	Up to 4.6 m		4.7 to 6.1 m		6.2 to 7.6 m		7.7 to 9.1 m		9.2 to 10.7 m		10.8 to 12.2 m	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
1.50	8.0	232	12.0	186	12.0	186	(Note 2)		(Note 2)		(Note 2)	
1.60	8.0	232	12.0	189	12.0	189	12.0	232 (Note 2)	(Note 2)		(Note 2)	
1.80	8.0	232	12.0	195	12.0	195	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.00	8.0	232	12.0	201	12.0	201	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.20	8.0	232	12.0	206	12.0	206	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.40	8.0	232	12.0	212	12.0	212	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.60	8.0	232	12.0	218	12.0	218	12.0	232 (Note 2)	(Note 2)		(Note 2)	
2.80	8.0	232	12.0	224	12.0	224	12.0	232 (Note 2)	(Note 2)		(Note 2)	
3.00	8.0	232	12.0	229	12.0	229	12.0	232 (Note 2)	(Note 2)		(Note 2)	
3.20	12.5	229	12.5	229	12.5	232	12.5	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
3.40	13.0	223	13.0	223	13.0	232	13.0	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
3.60	14.0	217	14.0	217	14.0	232	14.0	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
3.80	n/p		15.0	211	15.0	232	15.0	232	18.0	232 (Note 2)	(Note 2)	
4.00	n/p		15.5	205	15.5	232	15.5	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
4.20	n/p		16.5	199	16.5	232	16.5	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
4.40	n/p		17.0	192	17.0	232	17.0	232	18.0	232 (Note 2)	(Note 2)	(Note 2)
4.60	n/p		18.0	186	18.0	232	18.0	232	18.0	232	(Note 2)	(Note 2)
4.80	n/p		18.0	232	18.0	232	18.8	232	18.8	232	24.0	232 (Note 2)
5.00	n/p		18.0	232	18.0	232	19.6	232	19.6	232	24.0	232 (Note 2)
5.20	n/p				18.0	232	20.4	232	20.4	232	24.0	232 (Note 2)
5.40	n/p				18.0	232	21.2	232	21.2	232	24.0	232 (Note 2)
5.60	n/p				18.0	232	22.0	232	22.0	232	24.0	232 (Note 2)
5.80	n/p				18.0	232	22.8	232	22.8	232	24.0	232 (Note 2)
6.00	n/p				18.0	232	23.6	232	23.6	232	24.0	232 (Note 2)

Table 9.11(e) – Design criteria for category 6: Bin box storage (continued)

Max. storage height (m)	**Maximum roof/ceiling height**											
	Up to 4.6 m		**4.7 to 6.1 m**		**6.2 to 7.6 m**		**7.7 to 9.1 m**		**9.2 to 10.7 m**		**10.8 to 12.2 m**	
	rDD	**rDA**	**rDD**	**rDA**	**rDD**	**rDA**	**rDD**	**rDA**	**rDD**	**rDA**	**rDD**	**rDA**
6.20	n/p				24.0	232	24.0	232	n/p			
6.40	n/p				24.0	232	24.0	232	n/p			
6.60	n/p				24.0	232	24.0	232	n/p			
6.80	n/p						24.0	232	n/p			
7.00	n/p						24.0	232	n/p			
7.20	n/p						24.0	232	n/p			
7.40	n/p						24.0	232	n/p			
7.60	n/p						24.0	232	n/p			

Table 9.11(e) design constraints

(i) The requirements of this table are applicable, subject to the following design constraints:
(ii) A wet, dry or pre-action type system (see table entry notation 1).
(iii) Gridded pipework configurations are not permitted for, dry or pre-action systems (see 903.2).
(iv) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1 and 3).
(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.11(e) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the specified design area by 1.3 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. rDA – Roof/ceiling design area, m^2.
9. n/p – not permitted.

906.3 Rack storage height up to 7.6 m

Standard sprinkler system protection for categorised commodities stored in racks up to 7.6 m in height, shall be in accordance with tables 9.12(a) – (r).

Table 9.12(a) – Design criteria for category 1: Rack storage height up to 7.6 m, without solid shelves

Storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.2	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.4	6.50	n/r	—	6.50	n/r	—	6.00	n/r	—	6.00	n/r	—
3.6	6.50	n/r	—	6.50	n/r	—	6.50	n/r	—	6.50	n/r	—
3.8	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—	6.50	n/r	—
4.0	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—	6.50	n/r	—
4.2	7.50	n/r	—	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—
4.4	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—	7.00	n/r	—
4.6	8.00	n/r	—	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—
4.8	8.50	n/r	—	8.00	n/r	—	8.00	n/r	—	7.50	n/r	—
5.0	9.50	n/r	—	9.00	n/r	—	9.00	n/r	—	8.50	8.00	1
5.2	10.00	n/r	—	9.50	n/r	—	9.50	n/r	—	9.00	8.00	1
5.4	10.50	n/r	—	10.00	n/r	—	10.00	n/r	—	9.50	8.00	1
5.6	11.50	n/r	—	11.00	n/r	—	11.00	n/r	—	10.50	8.00	1
5.8	12.00	n/r	—	11.50	n/r	—	11.50	n/r	—	11.00	8.00	1
6.0	12.50	n/r	—	12.00	n/r	—	12.00	n/r	—	11.50	8.00	1
6.2	13.50	9.00	1	13.00	8.50	1	13.00	8.50	1	12.50	8.00	1
6.4	15.00	9.00	1	14.50	8.50	1	14.50	8.50	1	14.00	8.00	1
6.6	16.50	9.00	1	16.00	8.50	1	15.50	8.50	1	15.00	8.00	1
6.8	17.50	9.00	1	17.00	8.50	1	16.50	8.50	1	16.00	8.00	1
7.0	19.00	9.00	1	18.50	8.50	1	18.00	8.50	1	17.50	8.00	1
7.2	20.50	9.00	1	20.00	8.50	1	19.00	8.50	1	18.50	8.00	1
7.4	21.50	9.00	1	21.00	8.50	1	20.50	8.50	1	20.00	8.00	1
7.6	23.00	9.00	1	22.50	8.50	1	21.50	8.50	1	21.00	8.00	1

Table 9.12(a) design constraints

(i) The requirements of this table are applicable, subject to the following design constraints:

(ii) A wet, dry or pre-action type system (see table entry notation 1).

(iii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iv) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).

(v) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).

(vi) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(vii) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(viii) Design densities apply to Double Row Racks with varying aisle widths.
  - Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
  - Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
  - Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.

(ix) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(a) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. For encapsulated commodities adjust the design density as follows:
   (a) For roof/ceiling sprinklers only, multiply the roof/ceiling design density by 1.5.
   (b) For roof/ceiling and in-rack sprinklers, multiply the roof/ceiling design density by 1.25.
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, after making any adjustments for encapsulation, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.1.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling design area, m^2.
10. n/r – not required.

Table 9.12(b) – Design criteria for category 1: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m^2

Storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD mm/min		No. of IRS levels	rDD mm/min		No. of IRS levels	rDD mm/min		No. of IRS levels	rDD mm/min		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.2	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.4	6.50	n/r	—	6.50	n/r	—	6.00	n/r	—	6.00	n/r	—
3.6	6.50	n/r	—	6.50	n/r	—	6.50	n/r	—	6.50	n/r	—
3.8	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—	6.50	n/r	—
4.0	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—	6.50	n/r	—
4.2	7.50	n/r	—	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—
4.4	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—	7.00	n/r	—
4.6	8.00	n/r	—	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—
4.8	n/p	9.00	1	n/p	8.50	1	n/p	8.50	1	n/p	8.00	1
5.0	n/p	9.00	1	n/p	8.50	1	n/p	8.50	1	n/p	8.00	1
5.2	n/p	9.00	1	n/p	8.50	1	n/p	8.50	1	n/p	8.00	1
5.4	n/p	9.00	1	n/p	8.50	1	n/p	8.50	1	n/p	8.00	1
5.6	n/p	9.00	1	n/p	8.50	1	n/p	8.50	1	n/p	8.00	1
5.8	n/p	9.00	1	n/p	8.50	1	n/p	8.50	1	n/p	8.00	1
6.0	n/p	9.00	1	n/p	8.50	1	n/p	8.50	1	n/p	8.00	1
6.2	n/p	9.00	2	n/p	8.50	2	n/p	8.50	2	n/p	8.00	2
6.4	n/p	9.00	2	n/p	8.50	2	n/p	8.50	2	n/p	8.00	2
6.6	n/p	9.00	2	n/p	8.50	2	n/p	8.50	2	n/p	8.00	2
6.8	n/p	9.00	2	n/p	8.50	2	n/p	8.50	2	n/p	8.00	2
7.0	n/p	9.00	2	n/p	8.50	2	n/p	8.50	2	n/p	8.00	2
7.2	n/p	9.00	2	n/p	8.50	2	n/p	8.50	2	n/p	8.00	2
7.4	n/p	9.00	2	n/p	8.50	2	n/p	8.50	2	n/p	8.00	2
7.6	n/p	9.00	2	n/p	8.50	2	n/p	8.50	2	n/p	8.00	2

Table 9.12(b) design constraints

(i) The requirements of this table are applicable, subject to the following design constraints:

(ii) A wet, dry or pre-action type system (see table entry notation 1).

(iii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iv) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).

(v) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).

(vi) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(vii) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(viii) Design densities apply to Double Row Racks with varying aisle widths.
  - Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
  - Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
  - Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.

(ix) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(b) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustment is necessary for encapsulation (see 902.11).

5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.2.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. n/p – not permitted.
10. n/r – not required.

Table 9.12(c) – Design criteria for category 1: Rack storage height up to 7.6 m, solid shelves greater than 5.9 m^2

Maximum storage height (m)	**Aisle width** (m)											
	1.2			**1.6**			**2.0**			**2.4**		
	rDD (mm/min)		**No. of IRS levels**	**rDD** (mm/min)		**No. of IRS levels**	**rDD** (mm/min)		**No. of IRS levels**	**rDD** (mm/min)		**No. of IRS levels**
	Without IRS	**With IRS**		**Without IRS**	**With IRS**		**Without IRS**	**With IRS**		**Without IRS**	**With IRS**	
3.1	8.00	n/r	n/r	8.00	n/r	n/r	8.00	n/r	n/r	8.00	n/r	n/r
7.6	n/p	6.00	1@ET	n/p	6.00	1@ET	n/p	6.00	1@ET	n/p	6.00	1@ET

Table 9.12(c) design constraints

(i) The requirements of this table are applicable, subject to the following design constraints:

(ii) A wet, dry or pre-action type system (see table entry notation 1).

(iii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iv) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).

(v) The various design densities are applicable at the roof/ceiling level (see table entry notation 4).

(vi) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(vii) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(viii) Design densities apply to Double Row Racks with varying aisle widths:
- Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
- Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
- Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.

(ix) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(c) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustment is necessary for encapsulation (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. n/p – not permitted.
9. n/r – not required.
10. 1@ET – IRS levels spaced between 1.1 m and 1.8 m vertically.

Table 9.12(d) – Design criteria for category 2: Rack storage height up to 7.6 m, without solid shelves

Storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.2	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.4	6.50	n/r	—	6.50	n/r	—	6.50	n/r	—	6.50	n/r	—
3.6	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—	6.50	n/r	—
3.8	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—	7.00	n/r	—
4.0	8.00	n/r	—	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—
4.2	8.00	n/r	—	8.00	n/r	—	7.50	n/r	—	7.50	n/r	—
4.4	8.50	n/r	—	8.00	n/r	—	8.00	n/r	—	7.50	n/r	—
4.6	9.00	n/r	—	8.50	n/r	—	8.50	n/r	—	8.00	n/r	—
4.8	10.00	n/r	—	9.50	n/r	—	9.00	n/r	—	8.50	n/r	—
5.0	10.50	n/r	—	10.00	n/r	—	10.00	n/r	—	9.50	n/r	—
5.2	11.50	n/r	—	11.00	n/r	—	10.50	n/r	—	10.00	n/r	—
5.4	12.00	n/r	—	11.50	n/r	—	11.00	n/r	—	10.50	n/r	—
5.6	13.00	n/r	—	12.50	n/r	—	12.00	n/r	—	11.50	n/r	—
5.8	14.00	n/r	—	13.50	n/r	—	12.50	n/r	—	12.00	n/r	—
6.0	14.50	n/r	—	14.00	n/r	—	13.00	n/r	—	12.50	n/r	—
6.2	16.00	10.00	1	15.00	9.50	1	14.50	9.50	1	13.50	9.00	1
6.4	17.50	10.00	1	16.50	9.50	1	16.00	9.50	1	15.00	9.00	1
6.6	19.00	10.00	1	18.00	9.50	1	17.50	9.50	1	16.50	9.00	1
6.8	20.50	10.00	1	19.50	9.50	1	18.50	9.50	1	17.50	9.00	1
7.0	22.00	10.00	1	21.00	9.50	1	20.00	9.50	1	19.00	9.00	1
7.2	24.00	10.00	1	23.00	9.50	1	21.50	9.50	1	20.50	9.00	1
7.4	25.50	10.00	1	24.00	9.50	1	23.00	9.50	1	21.50	9.00	1
7.6	27.00	10.00	1	25.50	9.50	1	24.50	9.50	1	23.00	9.00	1

Table 9.12(d) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).

(iv) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).

(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vii) Design densities apply to Double Row Racks with varying aisle widths:
  - – Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
  - – Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
  - – Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.

(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(d) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. For encapsulated commodities adjust the design density, after making any adjustments for roof/ceiling sprinkler temperature rating, as follows:
   (a) For roof/ceiling sprinklers only, multiply the roof/ceiling design density by 1.5.
   (b) For roof/ceiling and in-rack sprinklers, multiply the roof/ceiling design density by 1.25.
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, after making any adjustments for encapsulation, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.1.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. n/r – not required.

Table 9.12(e) – Design criteria for category 2: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m^2

Storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.2	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.4	6.50	n/r	—	6.50	n/r	—	6.50	n/r	—	6.50	n/r	—
3.6	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—	6.50	n/r	—
3.8	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—	7.00	n/r	—
4.0	8.00	n/r	—	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—
4.2	8.00	n/r	—	8.00	n/r	—	7.50	n/r	—	7.50	n/r	—
4.4	8.50	n/r	—	8.00	n/r	—	8.00	n/r	—	7.50	n/r	—
4.6	9.00	n/r	—	8.50	n/r	—	8.50	n/r	—	8.00	n/r	—
4.8	n/p	10.00	1	n/p	9.50	1	n/p	9.50	1	n/p	9.00	1
5.0	n/p	10.00	1	n/p	9.50	1	n/p	9.50	1	n/p	9.00	1
5.2	n/p	10.00	1	n/p	9.50	1	n/p	9.50	1	n/p	9.00	1
5.4	n/p	10.00	1	n/p	9.50	1	n/p	9.50	1	n/p	9.00	1
5.6	n/p	10.00	1	n/p	9.50	1	n/p	9.50	1	n/p	9.00	1
5.8	n/p	10.00	1	n/p	9.50	1	n/p	9.50	1	n/p	9.00	1
6.0	n/p	10.00	1	n/p	9.50	1	n/p	9.50	1	n/p	9.00	1
6.2	n/p	10.00	2	n/p	9.50	2	n/p	9.50	2	n/p	9.00	2
6.4	n/p	10.00	2	n/p	9.50	2	n/p	9.50	2	n/p	9.00	2
6.6	n/p	10.00	2	n/p	9.50	2	n/p	9.50	2	n/p	9.00	2
6.8	n/p	10.00	2	n/p	9.50	2	n/p	9.50	2	n/p	9.00	2
7.0	n/p	10.00	2	n/p	9.50	2	n/p	9.50	2	n/p	9.00	2
7.2	n/p	10.00	2	n/p	9.50	2	n/p	9.50	2	n/p	9.00	2
7.4	n/p	10.00	2	n/p	9.50	2	n/p	9.50	2	n/p	9.00	2
7.6	n/p	10.00	2	n/p	9.50	2	n/p	9.50	2	n/p	9.00	2

Table 9.12(e) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).
(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(iii) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).
(iv) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).
(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vii) Design densities apply to Double Row Racks with varying aisle widths:
  - Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
  - Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
  - Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.
(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(e) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustments are necessary for encapsulation (see 902.11).
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, after making any adjustments for encapsulation, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.2.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. n/p – not permitted.
10. n/r – not required.

Table 9.12(f) – Design criteria for category 2: Rack storage height up to 7.6 m, solid shelves greater than 5.9 m^2

Maximum storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	8.00	n/r	—	8.00	n/r	—	8.00	n/r	—	8.00	n/r	—
7.6	n/p	6.00	1@ET	n/p	6.00	1@ET	n/p	6.00	1@ET	n/p	6.00	1@ET

Table 9.12(f) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).
(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(iii) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).
(iv) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).
(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vii) Design densities apply to Double Row Racks with varying aisle widths:
  - – Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
  - – Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
  - – Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.
(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(f) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustments are necessary for encapsulation (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. n/p – not permitted.
9. n/r – not required.
10. ET – one at each tier, IRS levels spaced between 1.1 m and 1.8 m vertically.

Table 9.12(g) – Design criteria for category 3: Rack storage height up to 7.6 m, without solid shelves

Storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.2	6.50	n/r	—	6.50	n/r	—	6.00	n/r	—	6.00	n/r	—
3.4	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—	6.50	n/r	—
3.6	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—	7.00	n/r	—
3.8	8.50	n/r	—	8.00	n/r	—	8.00	n/r	—	7.50	n/r	—
4.0	9.00	n/r	—	8.50	n/r	—	8.50	n/r	—	8.00	n/r	—
4.2	9.50	n/r	—	9.00	n/r	—	8.50	n/r	—	8.00	n/r	—
4.4	10.50	n/r	—	10.00	n/r	—	9.00	n/r	—	8.50	n/r	—
4.6	11.00	n/r	—	10.50	n/r	—	9.50	n/r	—	9.00	n/r	—
4.8	12.00	n/r	—	11.50	n/r	—	10.50	n/r	—	10.00	n/r	—
5.0	13.00	n/r	—	12.00	n/r	—	11.50	n/r	—	10.50	n/r	—
5.2	14.00	n/r	—	13.00	n/r	—	12.50	n/r	—	11.50	n/r	—
5.4	14.50	n/r	—	13.50	n/r	—	13.00	n/r	—	12.00	n/r	—
5.6	15.50	n/r	—	14.50	n/r	—	14.00	n/r	—	13.00	n/r	—
5.8	16.50	n/r	—	15.50	n/r	—	15.00	n/r	—	14.00	n/r	—
6.0	17.50	n/r	—	16.50	n/r	—	15.50	n/r	—	14.50	n/r	—
6.2	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
6.4	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
6.6	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
6.8	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
7.0	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
7.2	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
7.4	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
7.6	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1

Table 9.12(g) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).

(iv) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).

(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vii) Design densities apply to Double Row Racks with varying aisle widths.
  - Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
  - Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
  - Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.

(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(g) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. For encapsulated commodities adjust the design density as follows:
    (a) For roof/ceiling sprinklers only, multiply the roof/ceiling design density by 1.5;
    (b) For roof/ceiling and in-rack sprinklers, multiply the roof/ceiling design density by 1.25 (see 902.11).
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, after making any adjustments for encapsulation, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.1.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. n/p – not permitted.
10. n/r – not required.

Table 9.12(h) – Design criteria for category 3: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m^2

Storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—	6.00	n/r	—
3.2	6.50	n/r	—	6.50	n/r	—	6.00	n/r	—	6.00	n/r	—
3.4	7.00	n/r	—	7.00	n/r	—	6.50	n/r	—	6.50	n/r	—
3.6	7.50	n/r	—	7.50	n/r	—	7.00	n/r	—	7.00	n/r	—
3.8	8.50	n/r	—	8.00	n/r	—	8.00	n/r	—	7.50	n/r	—
4.0	9.00	n/r	—	8.50	n/r	—	8.50	n/r	—	8.00	n/r	—
4.2	9.50	n/r	—	9.00	n/r	—	8.50	n/r	—	8.00	n/r	—
4.4	10.50	n/r	—	10.00	n/r	—	9.00	n/r	—	8.50	n/r	—
4.6	11.00	n/r	—	10.50	n/r	—	9.50	n/r	—	9.00	n/r	—
4.8	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
5.0	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
5.2	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
5.4	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
5.6	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
5.8	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
6.0	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
6.2	n/p	12.00	2	n/p	11.50	2	n/p	10.50	2	n/p	10.00	2
6.4	n/p	12.00	2	n/p	11.50	2	n/p	10.50	2	n/p	10.00	2
6.6	n/p	12.00	2	n/p	11.50	2	n/p	10.50	2	n/p	10.00	2
6.8	n/p	12.00	2	n/p	11.50	2	n/p	10.50	2	n/p	10.00	2
7.0	n/p	12.00	2	n/p	11.50	2	n/p	10.50	2	n/p	10.00	2
7.2	n/p	12.00	2	n/p	11.50	2	n/p	10.50	2	n/p	10.00	2
7.4	n/p	12.00	2	n/p	11.50	2	n/p	10.50	2	n/p	10.00	2
7.6	n/p	12.00	2	n/p	11.50	2	n/p	10.50	2	n/p	10.00	2

Table 9.12(h) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).
(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(iii) A design area of 186m^2 at roof/ceiling level (see table entry notations 1 and 3).
(iv) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).
(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vii) Design densities apply to Double Row Racks with varying aisle widths:
  – Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
  – Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
  – Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.
(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(h) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustments are necessary for encapsulation (see 902.11).
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.2.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. n/p – not permitted.
10. n/r – not required.

Table 9.12(i) – Design criteria for category 3: Rack storage height up to 7.6 m, solid shelves greater than 5.9 m^2

Storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	8.00	n/r	—	8.00	n/r	—	8.00	n/r	—	8.00	n/r	—
7.6	n/p	6.00	1@ET	n/p	6.00	1@ET	n/p	6.00	1@ET	n/p	6.00	1@ET

Table 9.12(i) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).

(iv) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).

(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vii) Design densities apply to double row racks with varying aisle widths:
- Protect single row racks with aisles 1.2 m or greater, as double row racks.
- Protect single row racks with aisles less than 1.2 m as multiple row racks.
- Protect multiple row racks as double row racks with 1.2 m aisles.

(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(i) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustments are necessary for encapsulation (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. n/p – not permitted.
9. n/r – not required.
10. ET – IRS levels spaced between 1.1 m and 1.8 m vertically.

Table 9.12(j) – Design criteria for category 4: Rack storage height up to 7.6 m, without solid shelves

Storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	8.00	n/r	—	8.0	n/r	—	8.00	n/r	—	8.00	n/r	—
3.2	8.50	n/r	—	8.5	n/r	—	8.50	n/r	—	8.50	n/r	—
3.4	9.00	n/r	—	9.0	n/r	—	9.00	n/r	—	9.00	n/r	—
3.6	10.00	n/r	—	10.0	n/r	—	9.50	n/r	—	9.50	n/r	—
3.8	11.00	n/r	—	10.5	n/r	—	10.50	n/r	—	10.00	n/r	—
4.0	11.50	n/r	—	11.0	n/r	—	11.00	n/r	—	10.50	n/r	—
4.2	12.50	n/r	—	12.0	n/r	—	11.50	n/r	—	11.00	n/r	—
4.4	13.00	n/r	—	12.5	n/r	—	12.00	n/r	—	11.50	n/r	—
4.6	14.00	9.00	1	13.5	8.50	1	12.50	8.50	1	12.00	8.00	1
4.8	n/p	10.00	1	n/p	9.50	1	n/p	9.00	1	n/p	8.50	1
5.0	n/p	11.00	1	n/p	10.50	1	n/p	10.00	1	n/p	9.50	1
5.2	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
5.4	n/p	12.50	1	n/p	12.00	1	n/p	11.00	1	n/p	10.50	1
5.6	n/p	13.50	1	n/p	13.00	1	n/p	12.00	1	n/p	11.50	1
5.8	n/p	14.50	1	n/p	13.50	1	n/p	13.00	1	n/p	12.00	1
6.0	n/p	15.50	1	n/p	14.50	1	n/p	13.50	1	n/p	12.50	1
6.2	n/p	16.00	1	n/p	15.00	1	n/p	14.00	1	n/p	13.00	1
6.4	n/p	16.00	1	n/p	15.00	1	n/p	14.00	1	n/p	13.00	1
6.6	n/p	16.00	1	n/p	15.00	1	n/p	14.00	1	n/p	13.00	1
6.8	n/p	16.00	1	n/p	15.00	1	n/p	14.00	1	n/p	13.00	1
7.0	n/p	16.00	1	n/p	15.00	1	n/p	14.00	1	n/p	13.00	1
7.2	n/p	16.00	1	n/p	15.00	1	n/p	14.00	1	n/p	13.00	1
7.4	n/p	16.00	1	n/p	15.00	1	n/p	14.00	1	n/p	13.00	1
7.6	n/p	16.00	1	n/p	15.00	1	n/p	14.00	1	n/p	13.00	1

Table 9.12(j) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).

(iv) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).

(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vii) Design densities apply to Double Row Racks with varying aisle widths:
- Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
- Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
- Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.

(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(j) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. For encapsulated commodities adjust the design density as follows:
   (a) For roof/ceiling sprinklers only, multiply the roof/ceiling design density by 1.5;
   (b) For roof/ceiling and in-rack sprinklers, multiply the roof/ceiling design density by 1.25 (see 902.11).
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, after making any adjustments for encapsulation, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.1.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. n/p – not permitted.
10. n/r – not required.

Table 9.12(k) – Design criteria for category 4: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m^2

Maximum storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	8.00	n/r	—	8.00	n/r	—	8.00	n/r	—	8.00	n/r	—
3.2	8.50	n/r	—	8.50	n/r	—	8.50	n/r	—	8.50	n/r	—
3.4	10.00	n/r	—	10.00	n/r	—	10.00	n/r	—	10.00	n/r	—
3.6	11.50	n/r	—	11.50	n/r	—	11.50	n/r	—	11.50	n/r	—
3.8	12.50	n/r	—	12.50	n/r	—	12.50	n/r	—	12.50	n/r	—
4.0	14.00	n/r	—	14.00	n/r	—	14.00	n/r	—	14.00	n/r	—
4.2	15.50	n/r	—	15.50	n/r	—	15.50	n/r	—	15.50	n/r	—
4.4	16.50	n/r	—	16.50	n/r	—	16.50	n/r	—	16.50	n/r	—
4.6	18.00	9.00	1	18.00	8.50	1	18.00	8.50	1	18.00	8.00	1
4.8	n/p	10.00	1	n/p	9.50	1	n/p	9.00	1	n/p	8.50	1
5.0	n/p	11.00	1	n/p	10.50	1	n/p	10.00	1	n/p	9.50	1
5.2	n/p	12.00	1	n/p	11.50	1	n/p	10.50	1	n/p	10.00	1
5.4	n/p	12.50	1	n/p	12.00	1	n/p	11.00	1	n/p	10.50	1
5.6	n/p	13.50	1	n/p	13.00	1	n/p	12.00	1	n/p	11.50	1
5.8	n/p	14.50	1	n/p	13.50	1	n/p	13.00	1	n/p	12.00	1
6.0	n/p	15.50	1	n/p	14.50	1	n/p	13.50	1	n/p	12.50	1
6.2	n/p	16.00	2	n/p	15.00	2	n/p	14.00	2	n/p	13.00	2
6.4	n/p	16.00	2	n/p	15.00	2	n/p	14.00	2	n/p	13.00	2
6.6	n/p	16.00	2	n/p	15.00	2	n/p	14.00	2	n/p	13.00	2
6.8	n/p	16.00	2	n/p	15.00	2	n/p	14.00	2	n/p	13.00	2
7.0	n/p	16.00	2	n/p	15.00	2	n/p	14.00	2	n/p	13.00	2
7.2	n/p	16.00	2	n/p	15.00	2	n/p	14.00	2	n/p	13.00	2
7.4	n/p	16.00	2	n/p	15.00	2	n/p	14.00	2	n/p	13.00	2
7.6	n/p	16.00	2	n/p	15.00	2	n/p	14.00	2	n/p	13.00	2

Table 9.12(k) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system: (see table entry notation 1).
(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(iii) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).
(iv) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).
(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vii) Design densities apply to Double Row Racks with varying aisle widths:
  – Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
  – Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
  – Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.
(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(k) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustments are necessary for encapsulation (see 902.11) .
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.2.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. n/p – not permitted.
10. n/r – not required.

Table 9.12(I) – Design criteria for category 4: Rack storage height up to 7.6 m, solid shelves greater than 5.9 m^2

Storage height (m)	Aisle width (m)											
	1.2			1.6			2.0			2.4		
	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels	rDD (mm/min)		No. of IRS levels
	Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS		Without IRS	With IRS	
3.1	8.00	n/r	—	8.00	n/r	—	8.00	n/r	—	8.00	n/r	—
7.6	n/p	8.00	1@ET	n/p	8.00	1@ET	n/p	8.00	1@ET	n/p	8.00	1@ET

Table 9.12(I) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) A design area of 186 m^2 at roof/ceiling level (see table entry notations 1 and 3).

(iv) The various design densities are applicable at the roof/ceiling level (see table entry notations 4 and 5).

(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vii) Design densities apply to Double Row Racks with varying aisle widths:
   - Protect Single Row Racks with aisles 1.2 m or greater, as Double Row Racks;
   - Protect Single Row Racks with aisles less than 1.2 m as Multiple Row Racks;
   - Protect Multiple Row Racks as Double Row Racks with 1.2 m aisles.

(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(I) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3 (see 905.3).
4. No adjustments are necessary for encapsulation (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. n/p – not permitted.
9. n/r – not required.
10. ET – IRS levels spaced between 1.1 m and 1.8 m vertically.

Table 9.12(m) – Design criteria for category 5: Rack storage height up to 7.6 m, without solid shelves

Max storage height (m)	Maximum roof/ceiling height																															
	Up to 4.6 m		4.7 to 6.1 m						6.2 to 7.6 m						7.7 to 9.1 m						9.2 to 10.7 m						10.8 to 12.2 m				12.3 to 13.7 m	
	IRS levels		IRS levels						IRS levels						IRS levels						IRS levels						IRS levels				IRS levels	
	0		0		1		2		0		1		2		0		1		2		0		1		2		1		2		2	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
3.1	12.0	186	18.0	186	12.0	186	n/r		18.0	186	12.0	186	n/r		18.0	186	12.0	186	n/r		24.0	232 (Note 2)	12.0	186 (Note 2)	n/r		–	–	–	–	–	–
3.2	18.0	186	18.0	186	12.0	186	n/r		18.5	189	12.0	186	n/r		18.5	189	12.0	186	n/r		24.0	232 (Note 2)	12.0	186 (Note 2)	n/r		–	–	–	–	–	–
3.4	18.0	186	18.0	186	12.0	186	n/r		19.0	195	12.0	186	n/r		19.0	195	12.0	186	n/r		24.0	232 (Note 2)	12.0	186 (Note 2)	n/r		–	–	–	–	–	–
3.6	18.0	186	18.0	186	12.0	186	n/r		20.0	202	12.0	186	n/r		20.0	202	12.0	186	n/r		24.0	232 (Note 2)	12.0	186 (Note 2)	n/r		–	–	–	–	–	–
3.8	n/p		18.0	186	12.0	186	n/r		21.0	208	12.0	186	n/r		21.0	208	12.0	186	n/r		24.0	232 (Note 2)	12.0	186 (Note 2)	n/r		(Note 2)		(Note 2)		(Note 2)	
4.0	n/p		18.0	186	12.0	186	n/r		21.5	214	12.0	186	n/r		21.5	214	12.0	186	n/r		24.0	232 (Note 2)	12.0	186 (Note 2)	n/r		–	–	–	–	–	–
4.2	n/p		18.0	186	12.0	186	n/r		22.5	220	12.0	186	n/r		22.5	220	12.0	186	n/r		24.0	232 (Note 2)	12.0	186 (Note 2)	n/r		–	–	–	–	–	–
4.4	n/p		18.0	186	12.0	186	n/r		23.0	226	12.0	186	n/r		23.0	226	12.0	186	n/r		24.0	232 (Note 2)	12.0	186 (Note 2)	n/r		–	–	–	–	–	–
4.6	n/p		18.0	186	12.0	186	n/r		24.0	232	12.0	186	n/r		24.0	232	12.0	186	n/r		24.0	232	12.0	186	n/r		–	–	–	–	–	–
4.8	n/p		24.0	232	12.8	186	12.0	186	24.0	232	13.0	186	12.0	186	n/p		13.0	186	12.0	186	n/p		18.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	–	–

Table 9.12(m) – Design criteria for category 5: Rack storage height up to 7.6 m, without solid shelves (continued)

Maximum storage height (m)	Maximum roof/ceiling height																															
	Up to 4.6 m		4.7 to 6.1 m						6.2 to 7.6 m						7.7 to 9.1 m						9.2 to 10.7 m						10.8 to 12.2 m				12.3 to 13.7 m	
	IRS levels		IRS levels						IRS levels						IRS levels						IRS levels						IRS levels				IRS levels	
	0		0		1		2		0		1		2		0		1		2		0		1		2		1		2		2	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
5.0	n/p		24.0	232	13.6	186	12.0	186	24.0	232	13.5	186	12.0	186	n/p		13.5	186	12.0	186	n/p		18.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	–	–
5.2	n/p								24.0	232	14.5	186	12.0	186	n/p		14.5	186	12.0	186	n/p		18.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	–	–
5.4	n/p								24.0	232	15.0	186	12.0	186	n/p		15.0	186	12.0	186	n/p		18.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	(Note 2)	
5.6	n/p								24.0	232	16.0	186	12.0	186	n/p		16.0	186	12.0	186	n/p		18.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	–	–
5.8	n/p								24.0	232	17.0	186	12.0	186	n/p		17.0	186	12.0	186	n/p		18.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	–	(Note 2)
6.0	n/p								24.0	232	17.5	186	12.0	186	n/p		17.5	186	12.0	186	n/p		18.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	–	(Note 2)
6.2	n/p										18.5	183	12.0	186	n/p		18.5	183	12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
6.4	n/p										19.0	177	12.0	186	n/p		19.0	177	12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
6.6	n/p										20.0	171	12.0	186	n/p		20.0	171	12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)

Table 9.12(m) – Design criteria for category 5: Rack storage height up to 7.6 m, without solid shelves (continued)

Maximum storage height (m)	Maximum roof/ceiling height																															
	Up to 4.6 m		4.7 to 6.1 m						6.2 to 7.6 m						7.7 to 9.1 m						9.2 to 10.7 m						10.8 to 12.2 m				12.3 to 13.7 m	
	IRS levels		IRS levels						IRS levels						IRS levels						IRS levels						IRS levels				IRS levels	
	0		0		1		2		0		1		2		0		1		2		0		1		2		1		2		2	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
6.8	n/p																21.0	165	12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
7.0	n/p																21.5	159	12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
7.2	n/p																22.5	153	12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
7.4	n/p																23.0	146	12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
7.6	n/p																24.0	140	12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)

Table 9.12(m) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).
(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(iii) The various design densities and Design Areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 5).
(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904.
(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(m) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the Design Area by 1.3 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the Design Area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.1.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling Design Area, m².
10. n/p – not permitted.
11. n/r – not required.

Table 9.12(n) – Design criteria for category 5: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m^2

Maximum storage height (m)	Maximum roof/ceiling height																															
	Up to 4.6 m		4.7 to 6.1 m						6.2 to 7.6 m						7.7 to 9.1 m						9.2 to 10.7 m						10.8 to 12.2 m				12.3 to 13.7 m	
	IRS levels		IRS levels						IRS levels						IRS levels						IRS levels						IRS levels				IRS levels	
	0		0		1		2		0		1		2		0		1		2		0		1		2		1		2		2	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
3.1	12.0	186	18.0	186	12.0	186	—	—	18.0	186	12.0	186	—	—	18.0	186	12.0	186	—	—	24.0	232 (Note 2)	12.0	186 (Note 2)	—	—	—	—	—	—	—	—
3.2	18.0	186	18.0	186	12.0	186	—	—	18.5	189	12.0	186	—	—	18.5	189	12.0	186	—	—	24.0	232 (Note 2)	12.0	186 (Note 2)	—	—	—	—	—	—	—	—
3.4	18.0	186	18.0	186	12.0	186	—	—	19.0	195	12.0	186	—	—	19.0	195	12.0	186	—	—	24.0	232 (Note 2)	12.0	186 (Note 2)	—	—	—	—	—	—	—	—
3.6	18.0	186	18.0	186	12.0	186	—	—	20.0	201	12.0	186	—	—	20.0	201	12.0	186	—	—	24.0	232 (Note 2)	12.0	186 (Note 2)	—	—	—	—	—	—	—	—
3.8	n/p		18.0	186	12.0	186	n/r		21.0	207	12.0	186	n/r		21.0	207	12.0	186	n/r		24.0	232 (Note 2)	12.0	186 (Note 2)	n/r		(Note 2)		(Note 2)		(Note 2)	
4.0	n/p		18.0	186	12.0	186	—	—	21.5	214	12.0	186	—	—	21.5	214	12.0	186	—	—	24.0	232 (Note 2)	12.0	186 (Note 2)	—	—	—	—	—	—	—	—
4.2	n/p		18.0	186	12.0	186	—	—	22.5	220	12.0	186	—	—	22.5	220	12.0	186	—	—	24.0	232 (Note 2)	12.0	186 (Note 2)	—	—	—	—	—	—	—	—

Table 9.12(n) – Design criteria for category 5: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m^2 (continued)

Maximum storage height (m)	Maximum roof/ceiling height																															
	Up to 4.6 m		4.7 to 6.1 m						6.2 to 7.6 m						7.7 to 9.1 m						9.2 to 10.7 m						10.8 to 12.2 m				12.3 to 13.7 m	
	IRS levels		IRS levels						IRS levels						IRS levels						IRS levels						IRS levels				IRS levels	
	0		0		1		2		0		1		2		0		1		2		0		1		2		1		2		2	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
4.4	n/p		18.0	186	12.0	186	—	—	23.0	226	12.0	186	—	—	23.0	226	12.0	186	—	—	24.0	232 (Note 2)	12.0	186 (Note 2)	—	—	—	—	—	—	—	—
4.6	n/p		18.0	186	12.0	186	—	—	24.0	232	12.0	186	—	—	24.0	232	12.0	186	—	—	24.0	232	12.0	186	—	—	—	—	—	—	—	—
4.8	n/p						18.0	186	n/p		13.0	186	12.0	186	n/p		13.0	186	12.0	186	n/p		13.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	—	—
5.0	n/p						18.0	186	n/p		13.5	186	12.0	186	n/p		13.5	186	12.0	186	n/p		13.5	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	—	—
5.2	n/p										14.5	186	12.0	186	n/p		14.5	186	12.0	186	n/p		14.5	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	—	—
5.4	n/p										15.0	186	12.0	186	n/p		15.0	186	12.0	186	n/p		15.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	(Note 2)	
5.6	n/p										16.0	186	12.0	186	n/p		16.0	186	12.0	186	n/p		16.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	—	—
5.8	n/p										17.0	186	12.0	186	n/p		17.0	186	12.0	186	n/p		17.0	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	—	—

Table 9.12(n) – Design criteria for category 5: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m² (continued)

Maximum storage height (m)	Maximum roof/ceiling height																															
	up to 4.6 m		4.7 to 6.1 m						6.2 to 7.6 m						7.7 to 9.1 m						9.2 to 10.7 m						10.8 to 12.2 m				12.3 to 13.7 m	
	IRS levels		IRS levels						IRS levels						IRS levels						IRS levels						IRS levels				IRS levels	
	0		0		1		2		0		1		2		0		1		2		0		1		2		1		2		2	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
6.0	n/p										17.5	186	12.0	186	n/p		17.5	186	12.0	186	n/p		17.5	186	12.0	186	18.0	186 (Note 2)	12.0	186 (Note 2)	—	(Note 2)
6.2	n/p												12.0	186	n/p				12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
6.4	n/p												12.0	186	n/p				12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
6.6	n/p												12.0	186	n/p				12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
6.8	n/p																		12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
7.0	n/p																		12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
7.2	n/p																		12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
7.4	n/p																		12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)
7.6	n/p																		12.0	186	n/p				12.0	186	n/p		12.0	186	12.0	186 (Note 2)

Table 9.12 (n) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) The various design densities and Design Areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 5).

(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see Table entry notation 2).

(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12 (n) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the Design Area by 1.3.
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the Design Area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.2.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling Design Area, m².
10. n/p – not permitted.
11. n/r – not required.

Table 9.12(o) – Design criteria for category 5: Rack storage height up to 7.6 m, solid shelves greater than 5.9 m^2

Maximum storage height (m)	Maximum roof/ceiling height																					
	Up to 4.6 m				4.7 to 6.1 m				6.2 to 7.6 m				7.7 to 9.1 m				9.2 to 10.7 m		10.8 to 12.2 m		12.3 to 13.7 m	
	IRS levels				IRS levels				IRS levels				IRS levels				IRS levels		IRS levels		IRS levels	
	0		1@ET		0		1@ET		0		1@ET		0		1@ET		1@ET		1@ET		1@ET	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
3.1	12.0	186	n/r		18.0	186	n/r		18.0	186	n/r		18.0	186	n/r		12.0	186 (Note 2)	(Note 2)		(Note 2)	
7.6	n/p														12.0	186	12.0	186	12.0	186	12.0	186 (Note 2)

Table 9.12 (o) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) The various design densities and Design Areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 5).

(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12 (o) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the Design Area by 1.3 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the Design Area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Protection shall be provided beneath walkways in accordance with 905.10.2.
6. Steel column protection may be required, see 904.4.
7. rDD – Roof/ceiling design density, mm/min.
8. rDA – Roof/ceiling Design Area, m^2.
9. n/p – not permitted.
10. n/r – not required.
11. ET – one at each tier, IRS levels spaced between 1.1 m and 1.8 m vertically.

Table 9.12(p) – Part (a) Design criteria for category 6: Rack storage height up to 7.6 m without solid shelves – maximum roof/ceiling height up to 9.1 m

Maximum storage height (m)	Maximum roof/ceiling height																			
	Up to 7.6 m										7.7 to 9.1 m									
	IRS levels										IRS levels									
	0		1		2		3		4		0		1		2		3		4	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
3.1	24.0	280	12.0	186	–	–	–	–	–	–	24.0	280	12.0	186	–	–	–	–	–	–
3.2	n/p		12.5	186	–	–	–	–	–	–	n/p		12.5	186	–	–	–	–	–	–
3.4	n/p		13.0	186	–	–	–	–	–	–	n/p		13.0	186	–	–	–	–	–	–
3.6	n/p		14.0	186	n/r		n/r		n/r		n/p		14.0	186	n/r		n/r		n/r	
3.8	n/p		15.0	186	–	–	–	–	–	–	n/p		15.0	186	–	–	–	–	–	–
4.0	n/p		15.5	186	–	–	–	–	–	–	n/p		15.5	186	–	–	–	–	–	–
4.2	n/p		16.5	186	–	–	–	–	–	–	n/p		16.5	186	–	–	–	–	–	–
4.4	n/p		17.0	186	–	–	–	–	–	–	n/p		17.0	186	–	–	–	–	–	–
4.6	n/p		18.0	186	12.0	186	–	–	–	–	n/p		18.0	186	12.0	186	–	–	–	–
4.8	n/p		19.0	186	13.0	186	–	–	–	–	n/p		19.0	186	13.0	186	–	–	–	–
5.0	n/p		19.5	186	13.5	186	–	–	–	–	n/p		19.5	186	13.5	186	–	–	–	–
5.2	n/p		20.5	186	14.5	186	n/r		n/r		n/p		20.5	186	14.5	186	n/r		n/r	
5.4	n/p		21.0	186	15.0	186	–	–	–	–	n/p		21.0	186	15.0	186	–	–	–	–
5.6	n/p		22.0	186	16.0	186	–	–	–	–	n/p		22.0	186	16.0	186	–	–	–	–
5.8	n/p		23.0	186	17.0	186	–	–	–	–	n/p		23.0	186	17.0	186	–	–	–	–
6.0	n/p		23.5	186	17.5	186	–	–	–	–	n/p		23.5	186	17.5	186	–	–	–	–
6.2	n/p				24.0	186	18.0	186	12.0	186	n/p				18.5	186	12.5	186	12.0	186
6.4	n/p				24.0	186	18.0	186	12.0	186	n/p				19.0	186	13.0	186	12.0	186
6.6	n/p				24.0	186	18.0	186	12.0	186	n/p				20.0	186	14.0	186	12.0	186
6.8	n/p														21.0	186	15.0	186	12.0	186
7.0	n/p														21.5	186	15.5	186	12.0	186
7.2	n/p														22.5	186	16.5	186	12.0	186
7.4	n/p														23.0	186	17.0	186	12.0	186
7.6	n/p														24.0	186	18.0	186	12.0	186

Table 9.12 (p) – Part (a) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) The various design densities and Design Areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 5).

(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12 (p) – Part (a) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the Design Area by 1.3 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the Design Area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.1.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling Design Area, m^2.
10. n/p – not permitted.
11. n/r – not required.

Table 9.12(p) – Part (b) Design criteria for category 6: Rack storage height up to 7.6 m without solid shelves – Maximum roof/ceiling height from 9.2 m up to 13.7 m

Maximum storage height (m)	Maximum roof/ceiling height																					
	9.2 to 10.7 m								10.8 to 12.2 m								12.3 to 13.7 m					
	IRS levels								IRS levels								IRS levels					
	1		2		3		4		1		2		3		4		2		3		4	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
3.1	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3.2	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3.4	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3.6	18.0	186 (Note 2)	n/r		n/r		n/r		—	—	—	—	—	—	—	—	—	—	—	—	—	—
3.8	18.0	186 (Note 2)	—	—	—	—	—	—	(Note 2)		(Note 2)		(Note 2)		(Note 2)		(Note 2)		(Note 2)		(Note 2)	
4.0	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4.2	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4.4	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4.6	18.0	186	12.0	186	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4.8	19.0	186	18.0	186	—	—	—	—	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—
5.0	19.5	186	18.0	186	—	—	—	—	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—
5.2	20.5	186	18.0	186	n/r		n/r		24.0	186 (Note 2)	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—
5.4	21.0	186	18.0	186	—	—	—	—	24.0	186 (Note 2)	18.0	186 (Note 2)	(Note 2)		—		—	(Note 2)		(Note 2)	(Note 2)	
5.6	22.0	186	18.0	186	—	—	—	—	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—
5.8	23.0	186	18.0	186	—	—	—	—	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—
6.0	23.5	186	18.0	186	—	—	—	—	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—	—	—	—	—	—	—	—	—
6.2	n/p		24.0	186	12.5	186	12.0	186	n/p		18.5	186	12.5	186	12.0	186	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—
6.4	n/p		24.0	186	13.0	186	12.0	186	n/p		19.0	186	13.0	186	12.0	186	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—
6.6	n/p		24.0	186	14.0	186	12.0	186	n/p		20.0	186	14.0	186	12.0	186	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—
6.8	n/p		24.0	186	15.0	186	12.0	186	n/p		21.0	186	15.0	186	12.0	186	24.0	186 (Note 2)	18.0	186 (Note 2)	(Note 2)	
7.0	n/p		24.0	186	15.5	186	12.0	186	n/p		21.5	186	15.5	186	12.0	186	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—
7.2	n/p		24.0	186	16.5	186	12.0	186	n/p		22.5	186	16.5	186	12.0	186	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—
7.4	n/p		24.0	186	17.0	186	12.0	186	n/p		23.0	186	17.0	186	12.0	186	24.0	186 (Note 2)	18.0	186 (Note 2)	—	—
7.6	n/p		24.0	186	18.0	186	12.0	186	n/p		24.0	186	18.0	186	12.0	186	24.0	186 (Note 2)	18.0	186 (Note 2)	12.0	186 (Note 2)

Table 9.12 (p) – Part (b) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).
(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(iii) The various design densities and Design Areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 5).
(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12 (p) – Part (b) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the Design Area by 1.3.
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the Design Area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, in accordance with the requirements of table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.1.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling Design Area, m^2.
10. n/p – not permitted.
11. n/r – not required.

Table 9.12(q) – Design criteria for category 6: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m^2

Maximum storage height (m)	Maximum roof/ceiling height																															
	7.7 to 9.1 m										9.2 to 10.7 m								10.8 to 12.2 m								12.3 to 13.7 m					
	IRS levels										IRS levels								IRS levels								IRS levels					
	0		1		2		3		4		1		2		3		4		1		2		3		4		2		3		4	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
3.1	24.0	280	12.0	186	—	—	—	—	—		18.0	186 (Note 2)	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—
3.2	—		12.5	186	—	—	—	—	—		18.0	186 (Note 2)	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—
3.4	—		13.0	186	—	—	—	—	—		18.0	186 (Note 2)	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—
3.6	—		14.0	186	n/r		n/r		n/r		18.0	186 (Note 2)	n/r		n/r		n/r		—	—	—	—	—	—	—	—	—	—	—	—	—	—
3.8	—		15.0	186	—	—	—	—	—		18.0	186 (Note 2)	—	—	—	—	—		(Note 2)		(Note 2)		—	—	—	—	(Note 2)		—	—	—	—
4.0	—		15.5	186	—	—	—	—	—		18.0	186 (Note 2)	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—
4.2	—		16.5	186	—	—	—	—	—		18.0	186 (Note 2)	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—
4.4	—		17.0	186	—	—	—	—	—		18.0	186 (Note 2)	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—
4.6	n/p		18.0	186	12.0	186	12.0	186.0	—		18.0	186	12.0	186	—	—	—		—	—	—	—	—	—	—	—	—	—	—	—	—	—
4.8	—		19.0	186	13.0	186	12.0	186.0	—		19.0	186	13.0	186	12.0	186.0	—		24.0	186 (Note 2)	18.0	186 (Note 2)	12.0	186	—	—	—	—	—	—	—	—

Table 9.12(q) – Design criteria for category 6: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m^2 (continued)

Maximum storage height (m)	Maximum roof/ceiling height																															
	7.7 to 9.1 m										9.2 to 10.7 m								10.8 to 12.2 m								12.3 to 13.7 m					
	IRS levels										IRS levels								IRS levels								IRS levels					
	0		1		2		3		4		1		2		3		4		1		2		3		4		2		3		4	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
5.0	—		19.5	186	13.5	186	12.0	186.0	—		19.5	186	13.5	186	12.0	186.0	—		24.0	186 (Note 2)	18.0	186 (Note 2)	12.0	186	—	—	—	—	—	—	—	—
5.2	—		20.5	186	14.5	186	12.0	186.0	—		20.5	186	14.5	186	12.0	186.0	—		24.0	186 (Note 2)	18.0	186 (Note 2)	12.0	186	—	—	—	—	—	—	—	—
5.4	—		21.0	186	15.0	186	12.0	186.0	—		21.0	186	15.0	186	12.0	186.0	—		24.0	186 (Note 2)	18.0	186 (Note 2)	12.0	186	—	—	(Note 2)		—	—	—	—
5.6	—		22.0	186	16.0	186	12.0	186.0	—		22.0	186	16.0	186	12.0	186.0	—		24.0	186 (Note 2)	18.0	186 (Note 2)	12.0	186	—	—	—	—	—	—	—	—
5.8	—		23.0	186	17.0	186	12.0	186.0	—		23.0	186	17.0	186	12.0	186.0	—		24.0	186 (Note 2)	18.0	186 (Note 2)	12.0	186	—	—	—	—	—	—	—	—
6.0	—		23.5	186	17.5	186	12.0	186.0	n/r		23.5	186	17.5	186	12.0	186.0	n/r		24.0	186 (Note 2)	18.0	186 (Note 2)	12.0	186	—	—	—	—	—	—	—	—
6.2	—				18.5	186	12.5	186	—		—		18.5	186	12.5	186	—		—		18.5	186	12.5	186	—		24.0	186 (Note 2)	18.0	186 (Note 2)	—	—
6.4	—				19.0	186	13.0	186	—		—		19.0	186	13.0	186	—		—		19.0	186	13.0	186	—		24.0	186 (Note 2)	18.0	186 (Note 2)	—	—
6.6	—				20.0	186	14.0	186	—		—		20.0	186	14.0	186	—		—		20.0	186	14.0	186	—		24.0	186 (Note 2)	18.0	186 (Note 2)	—	—

Table 9.12(q) – Design criteria for category 6: Rack storage height up to 7.6 m, solid shelves 1.9 to 5.9 m^2 (continued)

Maximum storage height (m)	Maximum roof/ceiling height																															
	7.7 to 9.1 m										9.2 to 10.7 m								10.8 to 12.2 m								12.3 to 13.7 m					
	IRS levels										IRS levels								IRS levels								IRS levels					
	0		1		2		3		4		1		2		3		4		1		2		3		4		2		3		4	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
6.8	n/p				21.0	186	15.0	186	–		n/p		21.0	186	15.0	186	–		n/p		21.0	186	15.0	186	n/r		24.0	186 (Note 2)	18.0	186 (Note 2)	n/r	
7.0	–				21.5	186	15.5	186	–		–		21.5	186	15.5	186	–		–		21.5	186	15.5	186	–		24.0	186 (Note 2)	18.0	186 (Note 2)	–	–
7.2	–				22.5	186	16.5	186	–		–		22.5	186	16.5	186	–		–		22.5	186	16.5	186	–		24.0	186 (Note 2)	18.0	186 (Note 2)	–	–
7.4	–				23.0	186	17.0	186	–		–		23.0	186	17.0	186	–		–		23.0	186	17.0	186	–		24.0	186 (Note 2)	18.0	186 (Note 2)	–	–
7.6	–				24.0	186	18.0	186	–		–		24.0	186	18.0	186	–		–		24.0	186	18.0	186	–		24.0	186 (Note 2)	18.0	186 (Note 2)	12.0	186 (Note 2)

Table 9.12 (q) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) The various design densities and Design Areas are applicable at the roof/ceiling level (see Table entry notations 1, 3 and 5).

(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12 (q) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the Design Area by 1.3 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the Design Area by 1.3 (see 905.3).
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Where extra levels of in-rack sprinklers are provided, in excess of those specified in the table, adjust the design density, in accordance with the requirements of Table 9.8.
6. Protection shall be provided beneath walkways in accordance with 905.10.2.
7. Steel column protection may be required, see 904.4.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling Design Area, m^2.
10. n/p – not permitted.
11. n/r – not required.

Table 9.12(r) – Design criteria for category 6: Rack storage height up to 7.6 m, solid shelves greater than 5.9 m^2

Maximum storage height (m)	Maximum roof/ceiling height									
	up to 9.1 m				9.2 to 10.7 m		10.8 to 12.2 m		12.3 to 13.7 m	
	IRS levels				IRS levels		IRS levels		IRS levels	
	0		1@ET		1@ET		1@ET		1@ET	
	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA	rDD	rDA
3.1	24.0	280	12.0	186	12.0	186 (Note 2)	—	—	—	—
3.2	—		12.0	186	12.0	186 (Note 2)	—	—	—	—
3.4	—		12.0	186	12.0	186 (Note 2)	—	—	—	—
3.6	—		12.0	186	12.0	186 (Note 2)	—	—	—	—
3.8	n/p		12.0	186	12.0	186 (Note 2)	(Note 2)		(Note 2)	
4.0	—		12.0	186	12.0	186 (Note 2)	—	—	—	—
4.2	—		12.0	186	12.0	186 (Note 2)	—	—	—	—
4.4	—		12.0	186	12.0	186 (Note 2)	—	—	—	—
4.6	—		12.0	186	12.0	186	—	—	—	—
4.8	—		12.0	186	12.0	186	12.0	186 (Note 2)	—	—
5.0	—		12.0	186	12.0	186	12.0	186 (Note 2)	—	—
5.2	—		12.0	186	12.0	186	12.0	186 (Note 2)	—	—
5.4	n/p		12.0	186	12.0	186	12.0	186 (Note 2)	(Note 2)	
5.6	—		12.0	186	12.0	186	12.0	186 (Note 2)	—	—
5.8	—		12.0	186	12.0	186	12.0	186 (Note 2)	—	—
6.0	—		12.0	186	12.0	186	12.0	186 (Note 2)	—	—
6.2	—		12.0	186	12.0	186	12.0	186.0	12.0	186 (Note 2)
6.4	—		12.0	186	12.0	186	12.0	186.0	12.0	186 (Note 2)
6.6	—		12.0	186	12.0	186	12.0	186.0	12.0	186 (Note 2)
6.8	—		12.0	186	12.0	186	12.0	186.0	12.0	186 (Note 2)
7.0	—		12.0	186	12.0	186	12.0	186.0	12.0	186 (Note 2)
7.2	n/p		12.0	186	12.0	186	12.0	186.0	12.0	186 (Note 2)
7.4	—		12.0	186	12.0	186	12.0	186.0	12.0	186 (Note 2)
7.6	—		12.0	186	12.0	186	12.0	186.0	12.0	186 (Note 2)

Table 9.12(r) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1 and 3).

(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.12(r) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems multiply the design area by 1.3 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3, see 905.3.
4. No adjustment to these requirements is necessary for encapsulated commodities (see 902.11).
5. Steel column protection may be required (see 904.4).
6. Protection shall be provided beneath walkways in accordance with 905.10.2.
7. rDD – Roof/ceiling design density, mm/min.
8. rDA – Roof/ceiling design area, m^2.
9. n/p – not permitted.
10. ET – IRS levels spaced between 1.1 m and 1.8 m vertically.

906.4 Rack storage height greater than 7.6 m

Categorised commodities for rack storage height greater than 7.6 m, shall be in accordance with tables 9.13(a) to 9.13(f).

Table 9.13(a) – Design criteria for categories 1 to 6: Rack storage height greater than 7.6 m, single row rack without solid shelves, aisle width not less than 1.2 m and rack depth up to 2.7 m

Category	Approx. vert. IRS spacing[7 & 8] (m)	Vertical stagger required	Max. storage height above top IRS level (m)	rDD (mm/min)	rDA (m^2)	Figure no.
1, 2 and 3	3.1	Yes	3.1	10	186	9.23(a)
4				14		
5 and 6				18		

Table 9.13(a) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 4).

(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

(vii) Racks without solid shelves.

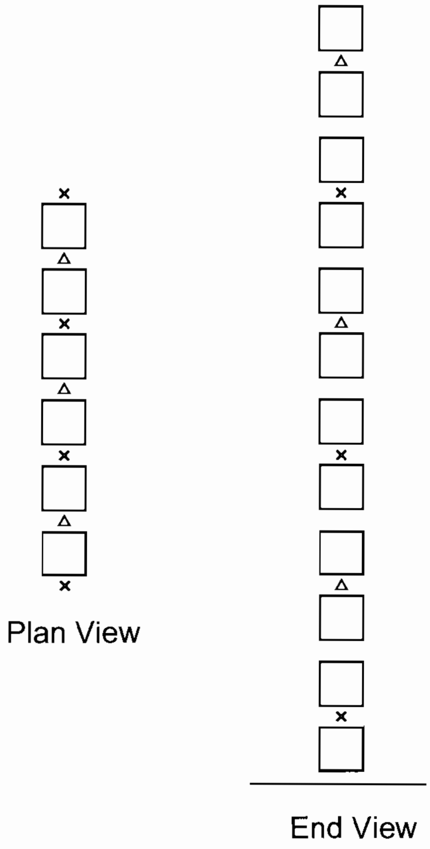
(viii) Aisle width not less than 1.2 m.

(ix) Racks with a maximum depth of 2.7 m.

(x) Non-encapsulated Category 1, 2, 3 and 4 commodities (see table entry notations 4 and 5).

Table 9.13(a) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3, see 905.3.
4. For encapsulated Category 1, 2, 3 and 4 commodities multiply the design density by 1.25.
5. No adjustment to these requirements is necessary for encapsulated Category 5 and 6 commodities (see 902.11).
6. The hydraulic design criteria of in-rack sprinklers shall comply with the requirements of table 9.9.
7. Approximate vertical spacing at the rack tier level nearest the vertical distance.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling design area, m^2.



NOTE – Symbols Δ or X indicate sprinklers on vertical or horizontal stagger.

Figure 9.23(a) – Rack storage height greater than 7.6 m – Categories 1 to 6: Single row rack without solid shelves, aisle width not less than 1.2 m and rack depth up to 2.7 m

Table 9.13(b) – Design criteria for categories 1 to 5: Rack storage height greater than 7.6 m, double row rack without solid shelves, aisle width not less than 1.2 m and rack depth up to 2.7 m

Category	IRS spacing (m)		Max. storage height above top IRS level (m)	rDD mm/min	rDA (m^2)	Figure no.
	Approx. vertical [7] & [8]	Max. horizontal				
1 to 5	3.1	1.5	1.5	12	186	9.23(b)
			3.1	18		

Table 9.13(b) design constraints

(i) The requirements of this table are applicable, subject to the following design constraints:

(ii) A wet, dry or pre-action type system (see table entry notation 1).

(iii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iv) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 4).

(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

(vii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

(viii) Racks without solid shelves.

(ix) Aisle width not less than 1.2 m.

(x) Racks with a maximum depth of 2.7 m.

(xi) Non-encapsulated Category 1, 2, 3 and 4 commodities (see table entry notations 4 and 5).

Table 9.13(b) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3, see 905.3.
4. For encapsulated Category 1, 2, 3 and 4 commodities multiply the design density by 1.25.
5. No adjustment to these requirements is necessary for encapsulated Category 5 commodities (see 902.11).
6. The hydraulic design criteria of in-rack sprinklers shall comply with the requirements of 905.12.2.
7. Approximate vertical spacing at the rack tier level nearest the vertical distance.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling design area, m^2.

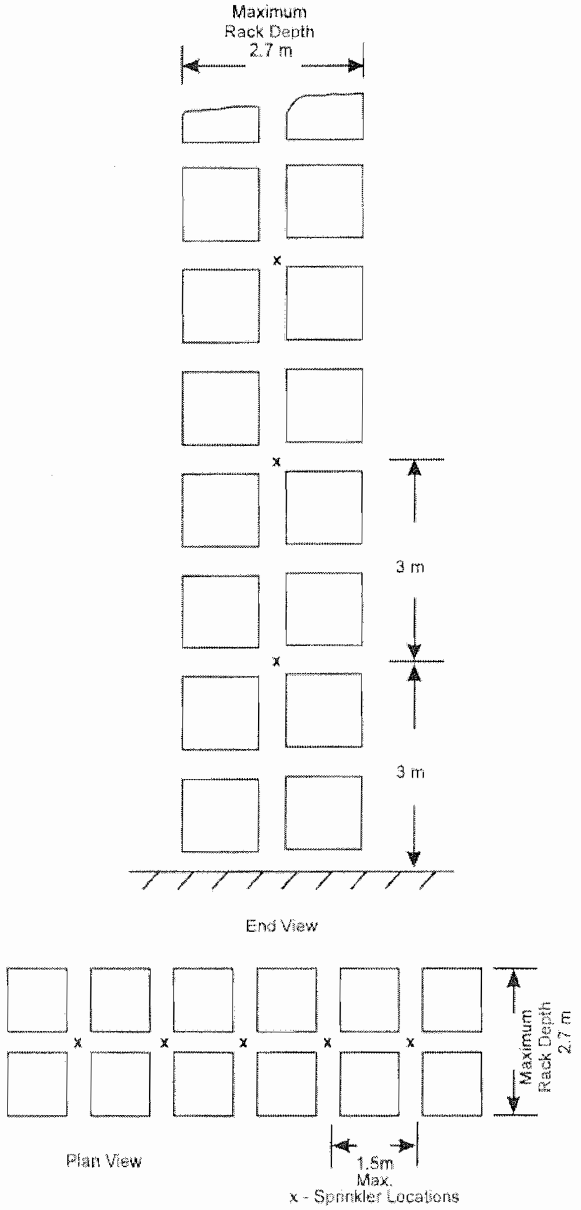


Figure 9.23(b) – Rack storage height greater than 7.6 m – Categories 1 to 5: Double row rack without solid shelves, aisle width not less than 1.2 m and rack depth up to 2.7 m

Table 9.13(c) – Design criteria for categories 1 to 5: Rack storage height greater than 7.6 m, double row rack without solid shelves, aisle width not less than 1.2 m and rack depth greater than 2.7 m

Category	IRS and face sprinkler spacing (m)		Max. storage height above top IRS level (m)	rDD (mm/min)	rDA (m^2)	Figure no.
	Approx. vertical [7]	**Max. horizontal**				
1 to 5	4.6	1.5	1.5	12	186	9.23(c)
			3.1	18		

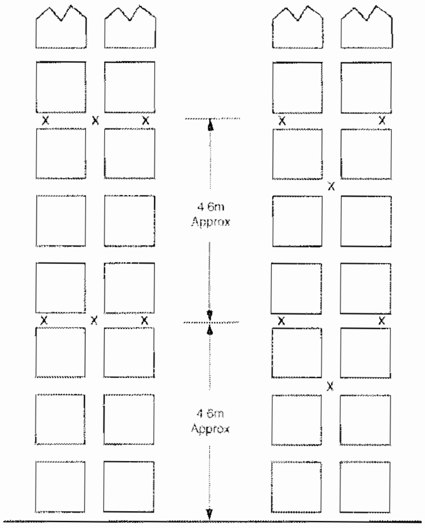
Table 9.13(c) design constraints

The requirements of this table are applicable, subject to the following design constraints:

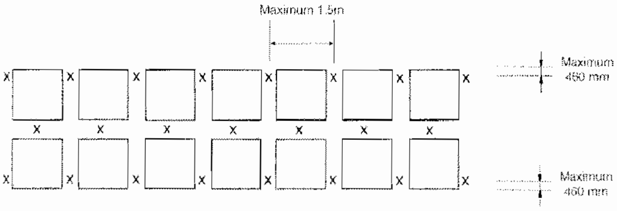
(i) A wet, dry or pre-action type system (see table entry notation 1).
(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(iii) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 4).
(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).
(vii) Racks without solid shelves.
(viii) Non-encapsulated Category 1, 2, 3 and 4 commodities (see table entry notations 4 and 5).

Table 9.13(c) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3, see 905.3.
4. For encapsulated Category 1, 2, 3 and 4 commodities multiply the design density by 1.25.
5. No adjustment to these requirements is necessary for encapsulated Category 5 commodities (see 902.11).
6. The hydraulic design criteria of in-rack sprinklers shall comply with the requirements of 905.12.2.
7. Approximate vertical spacing at the rack tier level nearest the vertical distance.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling design area, m^2.



End View



Plan View

NOTE – In-rack sprinklers nearest the aisle shall be placed within 460 mm of the face.

Figure 9.23(c) – Rack storage height greater than 7.6 m
– Categories 1 to 5: Double row rack without solid shelves, aisle width not less than 1.2 m and rack depth greater than 2.7 m

Table 9.13(d) – Design criteria for categories 1 to 5: Rack storage height greater than 7.6 m, multiple row rack without solid shelves or single/double row rack without solid shelves and aisle width less than 1.2 m

Category	IRS spacing (m)			Stagger spacing	Max. storage height above top IRS level (m)	rDD (mm/ min)	rDA (m^2)	Figure no.
	Approx. vertical [7] & [8]	Max. horizontal in flue	Max. horizontal across flue					
1 to 5	3.1	3.1	3.1	Yes	1.5	14	186	9.23(d)

Table 9.13(d) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 4).

(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) All four rack faces shall be protected by face sprinklers located within 460 mm of rack faces, at spacings as indicated in the table. Provided that the vertical spacing requirements are complied with, face sprinklers are not required to be at every level.

(vi) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

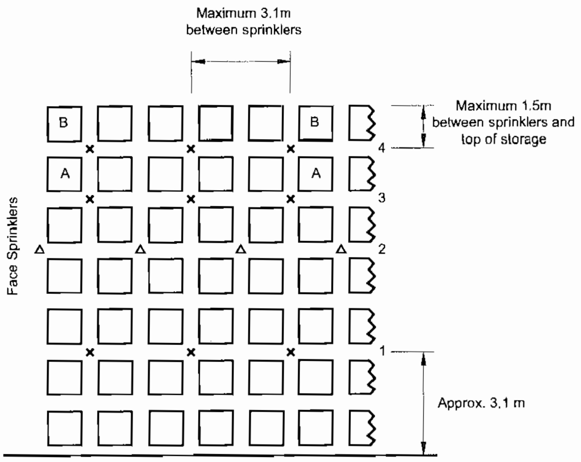
(vii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

(viii) Racks without solid shelves.

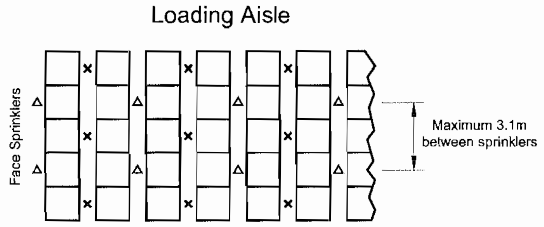
(ix) Non-encapsulated Category 1, 2, 3 and 4 commodities (see table entry notations 4 and 5).

Table 9.13(d) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3, see 905.3.
4. For encapsulated Category 1, 2, 3 and 4 commodities multiply the design density by 1.25.
5. No adjustment to these requirements is necessary for encapsulated Category 5 commodities (see 902.11).
6. The hydraulic design criteria of in-rack sprinklers shall comply with the requirements of table 9.9.
7. Approximate vertical spacing at the rack tier level nearest the vertical distance.
8. The maximum area per IRS shall be in accordance with the requirements of 904.2.7.
9. rDD – Roof/ceiling design density, mm/min.
10. rDA – Roof/ceiling design area, m^2.



Loading Aisle View



Loading Aisle Plan View

NOTE –

(1) Sprinklers labelled 1, 2 and 3 needed if loads labelled A represent top of storage.

(2) Sprinklers labelled 1, 2 and 4 needed if loads labelled B represent top of storage.

(3) For storage higher than represented by loads labelled B. the cycle defined by Notes 1 and 2 is repeated, with stagger as indicated.

(4) Symbols Δ or X indicate sprinklers on vertical or horizontal stagger.

Figure 9.23(d) – Rack storage height greater than 7.6 m – Categories 1 to 5: Multiple row rack without solid shelves or single/double row rack without solid shelves and aisle width less than 1.2 m

Table 9.13(e) – Design criteria for category 6: Rack storage height greater than 7.6 m, double row rack with aisle width not less than 1.2 m

Category	IRS and face sprinkler spacing (m)		Max. storage height above top IRS level (m)	rDD (mm/min)	rDA (m^2)	Figure no.
6	1.5	3.1	1.5	12	186	9.23(e)
			3.1	18		

Table 9.13(e) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet, dry or pre-action type system (see table entry notation 1).

(ii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).

(iii) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1, 3 and 4).

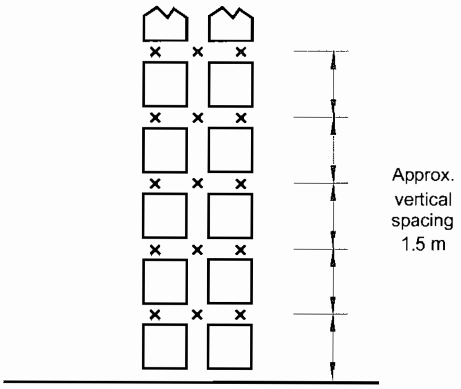
(iv) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.

(v) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).

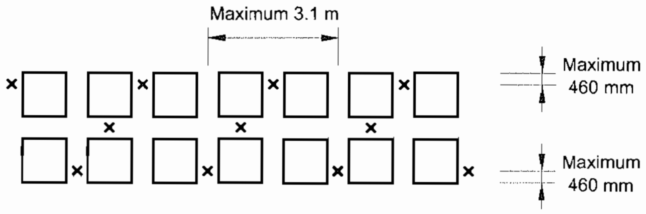
(vi) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.13(e) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3, see 905.3.
4. No adjustment to these requirements is necessary for encapsulated Category 5 and 6 commodities (see 902.11).
5. The hydraulic design criteria of in-rack sprinklers shall comply with the requirements of 905.12.2.
6. Approximate vertical spacing at the rack tier level nearest the vertical distance.
7. rDD – Roof/ceiling design density, mm/min.
8. rDA – Roof/ceiling design area, m^2.



End View



Plan View

NOTE – In-rack sprinklers shall be placed within 460 mm of the storage face.

Figure 9.23(e) – Rack storage height greater than 7.6 m – Category 6: Double row rack with aisle width not less than 1.2 m

Table 9.13(f) – Design criteria for category 6: Rack storage height greater than 7.6 m, multiple row rack or single/double row rack and aisle width less than 1.2 m

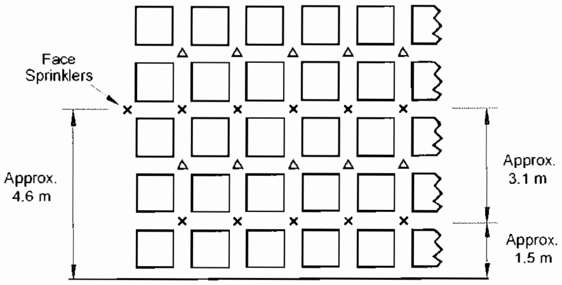
Category	IRS spacing (m)			Face sprinkler spacing (m)		Vertical stagger spacing	Max. storage height above top IRS level (m)	rDD (mm/min)	rDA (m^2)	Figure no.
	Approx. vertical[6]	Max. horizontal flue	Max. horizontal across flue	Approx vertical [6]	Max. horizontal					
6	1.5	2.4	3.1	4.6	2.4	Yes	1.5	12	186	9.23(f)
							3.1	18		

Table 9.13(f) design constraints

(i) The requirements of this table are applicable, subject to the following design constraints:
(ii) A wet, dry or pre-action type system (see table entry notation 1).
(iii) Gridded pipework configurations are not permitted for dry or pre-action systems (see 903.2).
(iv) The various design densities and design areas are applicable at the roof/ceiling level (see table entry notations 1 and 3).
(v) The installation of sprinklers at roof/ceiling level in accordance with the requirements of 904 and 905.
(vi) All four rack faces shall be protected by face sprinklers located within 460 mm of rack faces, at spacings as indicated in the table. Provided that the vertical spacing requirements are complied with, face sprinklers are not required to be at every level.
(vii) A maximum clearance of 6.1 m from the top of the storage to the underside of the roof/ceiling (see table entry notation 2).
(viii) Roof/ceiling slope up to 1 in 6 (10°) (see table entry notation 3).

Table 9.13(f) entry notations (modifications and additional design requirements)

1. For dry or pre-action systems, increase the design area to 248 m^2 (see 903.2).
2. For clearance in excess of 6.1 m, see 905.12.4.
3. For roof/ceiling slopes greater than 1 in 6 (10°), multiply the design area by 1.3, see 905.3.
4. No adjustment to these requirements is necessary for encapsulated Category 5 and 6 commodities (see 902.11).
5. The hydraulic design criteria of in-rack sprinklers shall comply with the requirements of table 9.9.
6. Approximate vertical spacing at the rack tier level nearest the vertical distance.
7. The maximum area per IRS shall be in accordance with the requirements of 904.2.7.
8. rDD – Roof/ceiling design density, mm/min.
9. rDA – Roof/ceiling design area, m^2.



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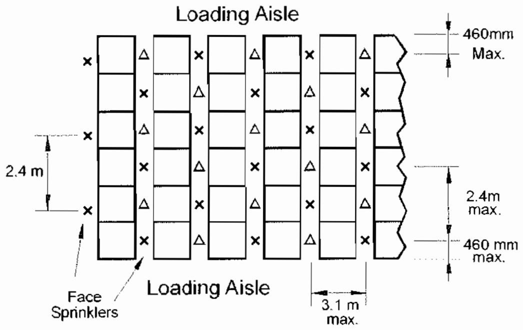


Plan View

NOTE – Symbols Δ or X indicate sprinklers on vertical or horizontal stagger.

Figure 9.23(f) – Rack storage height greater than 7.6 m – Category 6: Multiple row rack or single/double row rack and aisle width less than 1.2 m

907 SPECIAL COMMODITIES

This section specifies the requirements and provides the necessary information and procedures for the design of standard sprinkler system protection for the following commodities:

(a) Rubber tyre storage (see 907.1);

(b) Roll paper storage (see 907.2);

(c) Baled fibres and waste paper storage (see 907.3);

(d) Hanging garment storage (see 907.4);

(e) Carpet storage (see 907.5);

(f) Idle pallet storage (see 907.6);

(g) Aerosols storage (see 907.7);

(h) Distilled spririts storage (see 907.8).

907.1 Rubber tyre storage

This clause specifies the requirements and provides necessary information and procedures for the design of standard sprinkler system protection of rubber tyre storage, including passenger car, truck and tractor, motorcycle and bicycle tyres, rubber tyres mounted on metal wheels, and green tyres, (see 902.15).

Storage locations include warehouses and indoor locations other than warehouses, (see 902.21).

A brief description of rubber tyre storage terms can be found in 902.

907.1.1 *Prerequisites to the sprinkler system design criteria*

The sprinkler design requirements of this clause apply only to the protection of rubber tyre storage within buildings in which:

(a) Sufficient clearance from top of storage to roof/ceilings or mezzanines is maintained to ensure that sprinklers will be at least 900 mm clear of storage;

(b) When tyres are stored on-tread, the dimension of the pile in the direction of the wheel hole, does not exceed 7.7 m between aisles or vertical barriers. Dimensions in the direction of wheel holes need not be considered when in-rack sprinklers or high-expansion foam systems are installed (see 907.1.6);

(c) Aisles at least 2.5 m wide are maintained between piles of tyres and between tyre storage and any other combustible storage;

(d) Horizontal barriers, (see 902.17) are installed within racks under some conditions, where specified by the tables and figures for rubber tyre storage.

907.1.2 *General*

The general design and hydraulic design requirements of 904 and 905 shall apply, unless otherwise specified for rubber tyre storage. Due to the peculiarities of tyre storage, there are several requirements that differ from those specified in 904 and 905, including the following:

(a) *System type.*

  (i) Where there is no likelihood of freezing, systems shall be wet type

  (ii) Where there is likelihood of freezing, a pre-action system shall be installed in accordance with the requirements of 302.4;

  NOTE – Dry Systems are not suitable for sprinkler protection of rubber tyre storage.

(b) *Sprinkler types and temperature rating.* Roof/ceiling sprinklers shall be in accordance with the requirements of 904.1.1 and 904.1.2 for categorised commodities, except that:

  (i) Spray sprinklers shall have a nominal temperature rating of 141 °C, and

  (ii) Spray sprinklers shall have a nominal orifice size of 20 mm.

  In-rack sprinklers shall be in accordance with the requirements of 904.2.1.

  Control mode specific application and suppression mode Sprinklers shall be installed in accordance with 907.1.7 and 907.1.8 respectively;

(c) *Clearance over storage.* Clearance from top of storage to sprinklers below roofs/ceilings or mezzanines shall be at least 900 mm;

(d) *Column protection.* Exposed steel column protection is required for on-floor storage or on-side storage in fully loaded portable tyre racks when storage heights are 4.6 m and greater unless the roof/ceiling sprinklers can provide both a 37 mm/min minimum density over the hydraulically most disadvantaged 279 m^2 design area, and a 24 mm/min density over the hydraulically most disadvantaged 464 m^2 design area.

  Where sprinkler protection of building columns is necessary one of the following requirements shall apply:

   (i) A sidewall sprinkler installed on each building column, located between 3.1 m to 4.6 m elevation, pointed towards one side of the steel column, capable of providing a flow rate of at least 114 L/min. The flow rate from each sidewall sprinkler within the design area shall be added to the flow rate required for roof/ceiling sprinklers when sizing system pipework. At the point where column protection pipework meets the roof/ceiling pipework, the respective flows shall be balanced in accordance with the requirements of Part 10, or

   (ii) For hollow tube or box columns provide two sidewall sprinklers, on opposite corners of the column, directed at the column located between 3.1 to 4.6 m level, capable of providing a combined flow rate of at least 114 L/min;

(e) *Tyre racks with solid or slatted shelves.* Sprinklers shall be installed at the roof/ceiling level and in-rack sprinklers shall be installed beneath each level of shelving in all types of tyre racks having solid or slatted shelves. However, in-rack sprinklers may be omitted if high-expansion foam systems are installed (see 907.1.6);

(f) *Single-row racks.* Single-row racks shall be protected in the same manner as double-row racks.

907.1.3 *Roof/ceiling sprinkler hydraulic design*

Sprinklers at roof/ceiling level shall be designed in accordance with the requirements of tables 9.14(a) to 9.14(d) as appropriate to the storage arrangement, as follows:

(a) *In warehouses.*

   (i) Table 9.14(a) shall apply when storage is on-side in permanent tyre racks or in partially loaded portable tyre racks

   (ii) Table 9.14(b) shall apply when storage is on-tread in permanent or portable tyre racks

   (iii) Table 9.14(c) shall apply when storage is on-floor or on-side in fully loaded portable tyre racks;

(b) *In locations other than warehouses and green tyre storage.* Table 9.14(d) shall apply when storage is at a location other than a warehouse, such as retail stores, fleet garages and service centres. table 9.14(d) shall also apply for green tyre storage in manufacturing areas.

Table 9.14(a) – On-side storage in permanent tyre racks or partially loaded portable tyre racks, without solid shelves

Type of rack	Height of storage (m)	rDD (mm/min)	rDA m^2[2]		Clearance[1] (m)
			Wet system	Pre-action system	
Section A: Portable, single/ double row and multiple row	1.5	12.0	279	363	3
	1.6	12.5	279	363	3
	1.8	13.0	279	363	3
	2.0	14.0	279	363	3
	2.2	15.0	279	363	3
	2.4	15.5	279	363	3
	2.6	16.5	279	363	3
	2.8	17.0	279	363	3
	3.0	18.0	279	363	3
	3.2	19.0	279	363	3
	3.4	19.5	279	363	3
	3.6	20.5	279	363	3
	3.8	21.0	279	363	3
	4.0	22.0	279	363	3
	4.2	23.0	279	363	3
	4.4	23.5	279	363	3
	4.5	24.0	279	363	3
	4.6 - 7.5	37 and 24	279 and 464	363 and 604	3
	7.5 - 9.0	12	279	363	3
		Plus high-expansion foam, see 907.1.6			
Section B: Alternative protection for single double row	Any height over 4.5	Provide			3
		1. (a) Horizontal barriers every 6 m vertically as in figure 9.24(a) with two lines of in-rack sprinklers under each barrier [3], or			
		(b) In-rack sprinklers every 4.5 m vertically as in figure 9.24(b).			
		and			
		2. Provide roof/ceiling sprinkler protection based on the height of storage above the top barrier/level of in-rack sprinklers [4].			
Section C: Alternative protection for multiple row	Any height over 4.5	Provide			3
		1. In-rack sprinklers every 3.0 m vertically as in figure 9.24(c)			
		and			
		2. Provide roof/ceiling sprinkler protection based on the height of storage above the top barrier/level of in-rack sprinklers [4].			

Table 9.14(a) entry notations (modifications and additional design requirements)

1. When clearance between top of storage and roof/ceiling sprinklers is greater than 3 m, one of the following two options shall apply:

   Option 1: Protection shall be provided that complies with the requirements of Section A of table 9.14(a) for a storage height which would correspond to a maximum clearance of 3 m. For example, if storage is 2 m high in a 6 m high building the sprinkler protection shall satisfy the requirements for 3 m high storage).

   Option 2: A horizontal barrier shall be installed over the top of storage, with in-rack sprinklers installed beneath the barrier in accordance with the requirements of 907.1.4. Roof/ceiling density shall be 8 mm/min over 186 m^2.

2. When clearance between top of storage and roof/ceiling sprinklers is not more than 1.5 m, the design area may be reduced by 25 %.
3. When Double Row Racks are deeper than 3.7 m, at least three lines of in-rack sprinklers shall be installed under each barrier.
4. When storage is less than 1.5 m high above the top barrier/level of in-rack sprinkler protection, the design area may be reduced by 15 %.
5. See 902.32 for definition of ‘Partial Loads’.
6. For racks with solid or slatted shelves, see 907.1.2(e).
7. rDD – Roof/ceiling design density, mm/min.
8. rDA – Roof/ceiling design area, m^2.

Table 9.14(b) – On tread storage in permanent tyre racks or portable tyre racks, without solid shelves

<table>
<tr><th rowspan="2">Type of rack</th><th rowspan="2">Height of Storage (m)</th><th rowspan="2">rDD (mm/min)</th><th colspan="2">rDA (m^2)[2]</th><th rowspan="2">Clearance [1] (m)</th></tr>
<tr><th>Wet system</th><th>Pre-action system</th></tr>
<tr><td rowspan="15">Section A: Portable single/ double row and multiple row</td><td>1.5</td><td>12.0</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>1.6</td><td>12.5</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>1.8</td><td>13.0</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>2.0</td><td>14.0</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>2.2</td><td>14.5</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>2.4</td><td>16.0</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>2.6</td><td>17.5</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>2.8</td><td>18.5</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>3.0</td><td>20.0</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>3.2</td><td>21.5</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>3.4</td><td>22.5</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>3.6</td><td>24.0</td><td>279</td><td>363</td><td>3</td></tr>
<tr><td>3.7 - 6.0</td><td>37.0
and
24.0</td><td>279
and
464</td><td>363
and
604</td><td>3</td></tr>
<tr><td rowspan="2">6.1 - 9.0</td><td>12.0</td><td>279</td><td>363</td><td rowspan="2">3</td></tr>
<tr><td colspan="3">Plus high-expansion foam, see 907.1.6</td></tr>
<tr><td rowspan="5">Section B: Alternative protection for single/ double row</td><td rowspan="5">Any height over 3.6</td><td colspan="3">Provide</td><td rowspan="5">3</td></tr>
<tr><td colspan="3">1. (a) Horizontal barriers every 4.5 m vertically as in figure 9.24(d) with two lines of in-rack sprinklers under each barrier [3], or</td></tr>
<tr><td colspan="3">(b) In-rack sprinklers every 3.0 m vertically as in figure 9.24(e).</td></tr>
<tr><td colspan="3">And</td></tr>
<tr><td colspan="3">2. Provide roof/ceiling sprinkler protection based on the height of storage above the top barrier/level of in-rack sprinklers [4].</td></tr>
<tr><td rowspan="4">Section C: Alternative protection for multiple row</td><td rowspan="4">Any height over 3.6</td><td colspan="3">Provide</td><td rowspan="4">3</td></tr>
<tr><td colspan="3">1. In-rack sprinklers every 1.5 m vertically and face sprinklers every 4.5 m vertically, as in figure 9.24(f).</td></tr>
<tr><td colspan="3">and</td></tr>
<tr><td colspan="3">2. Provide roof/ceiling sprinkler protection based on the height of storage above the top barrier/level of in-rack sprinklers [4].</td></tr>
</table>

Table 9.14(b) entry notations (modifications and additional design requirements)

1. When clearance between top of storage and roof/ceiling sprinklers is greater than 3 m, one of the following two options shall apply:

   Option 1: Protection shall be provided that complies with the requirements of Section A of table 9.14(b) for a storage height which would correspond to a maximum clearance of 3 m. For example, if storage is 2 m high in a 6 m high building the sprinkler protection shall satisfy the requirements for 3 m high storage).

   Option 2: A horizontal barrier shall be installed over the top of storage, with in-rack sprinklers installed beneath the barrier in accordance with the requirements of 907.1.4. Roof/ceiling density shall be 8 mm/min over 186 m^2.
2. When clearance between top of storage and roof/ceiling sprinklers is not more than 1.5 m, the design area may be reduced by 25 %.
3. When Double Row Racks are deeper than 3.7 m, at least three lines of in-rack sprinklers shall be installed under each barrier.
4. When storage is less than 1.5 m high above the top barrier/level of in-rack sprinkler protection, the design area may be reduced by 15 %.
5. For racks with solid or slatted shelves, see 907.1.2(e).
6. rDD – Roof/ceiling design density, mm/min.
7. rDA – Roof/ceiling design area, m^2.

Table 9.14(c) – On floor or on side storage in fully loaded portable tyre racks

Height of storage (m)	rDD (mm/min)	rDA (m²) [1]	
		Wet system	**Pre-action system**
1.5	10.0	186	242
1.6	10.5		
1.8	11.0		
2.0	11.5		
2.2	12.0		
2.4	12.5		
2.6	13.0		
2.8	13.5		
3.0	14.0		
3.2	14.5		
3.4	15.0		
3.6	15.5		
3.8	16.0		
4.0	16.5		
4.2	17.0		
4.4	17.5		
4.5 [2]	18.0	279	363
4.6 [2]	18.5		
4.8 [2]	19.0		
5.0 [2]	20.0		
5.2 [2]	21.0		
5.4 [2]	21.5		
5.6 [2]	22.5		
5.8 [2]	23.0		
6.0 [2]	24.0		
6.0 - 9.1	12.0	279	363
		Plus high-expansion foam, see 907.1.6	

Table 9.14(c) entry notations (modifications and additional design requirements)

1. When clearance between top of storage and roof/ceiling sprinkler is about 900 mm, the design area may be reduced by 25 %, to not less than 186 m^2.
2. Provide steel column protection as specified in 907.1.2(d).
3. See 902.16 for definition of 'fully loaded'.
4. rDD – Roof/ceiling design density, mm/min.
5. rDA – Roof/ceiling design area, m^2.

Table 9.14(d) – Locations other than warehouses and 'green' tyres

Arrangement	Height of storage (m)	rDD (mm/min)	rDA (m^2)
Locations other than warehouses	2.4	18	186
On-tread, fixed, double row racks	Greater than 2.4 up to 4.0	12 plus 1 level of in-rack sprinklers	229
Green tyres, in portable carts, 1-cart high	2.4	8	279
Green tyres, in portable carts, 2-carts high	Greater than 2.4 up to 4.0	12 or	368 or
		14 or	279 or
		16	186

Table 9.14(d) entry notations (modifications and additional design requirements)

1. See 902.21 for definition of 'locations other than warehouses'.
2. See 902.15 for definition of 'green' tyres.
3. rDD – Roof/ceiling design density, mm/min.
4. rDA – Roof/ceiling design area, m^2.

907.1.4 *In-rack sprinkler hydraulic design*

When in-rack sprinklers are a requirement of 907.1.2(e), table 9.14(a) or table 9.14(b), they shall be hydraulically designed, based on the simultaneous operation of the hydraulically most disadvantaged 10 sprinklers on each of two adjacent levels or the hydraulically most disadvantaged 12 sprinklers if only one level is required.

Where in-rack sprinklers are a requirement of table 9.14(d), they shall be hydraulically designed, based on the simultaneous operation of the hydraulically most disadvantaged six sprinklers.

The minimum rate of flow from each operating in-rack sprinkler shall be 114 L/min.

In the sizing of distribution pipework, the water flow required for the in-rack sprinklers shall be added to that required for the roof/ceiling sprinklers and sprinklers protecting building columns. At the points where the in-rack pipework meets the roof/ceiling pipework, the respective flows shall be balanced in accordance with Part 10.

907.1.5 *In-rack sprinkler spacing and area coverage*

Where in-rack sprinklers are a requirement of 907.1.2(e) or tables 9.14(a) and 9.14(b), the spacing of sprinklers along the length of tyre racks shall not exceed the following:

(a) For single and double row racks .... 3 m

(b) For multiple-row racks .... 2.4 m.

In multiple row racks the area of coverage per sprinkler shall not exceed 7.4 m^2 in the horizontal plane.

Where in-rack sprinklers are a requirement of table 9.14(d), they shall be installed in each double row rack as shown in figure 9.7 at a maximum horizontal spacing of 2.4 m, and with a maximum area coverage per sprinkler of 6 m^2 in the horizontal plane.

Sprinklers in longitudinal flues of tyre racks shall be located a minimum of 600 mm from tyre rack uprights, (see figures 9.24(a) to 9.25(f)) for horizontal and vertical spacing.

When horizontal barriers are installed in double row racks with an overall depth greater than 3.7 m, three lines of in-rack sprinklers shall be installed beneath each barrier (see Note 3, tables 9.14(a) and 9.14(b)).

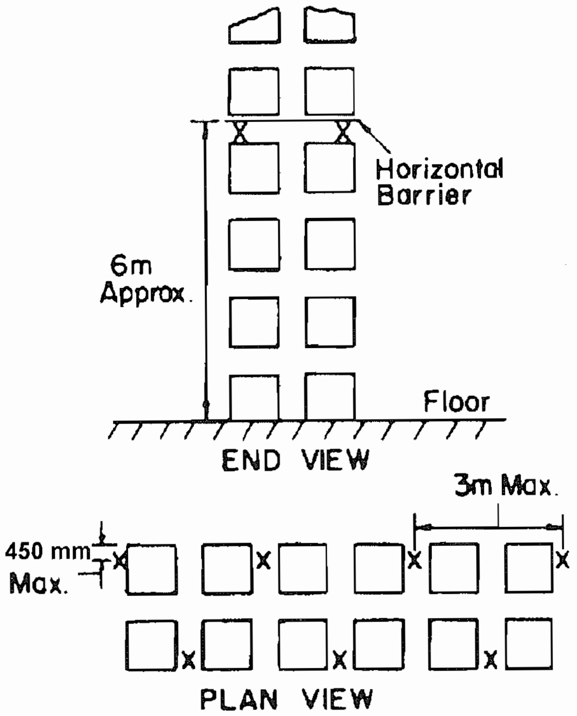
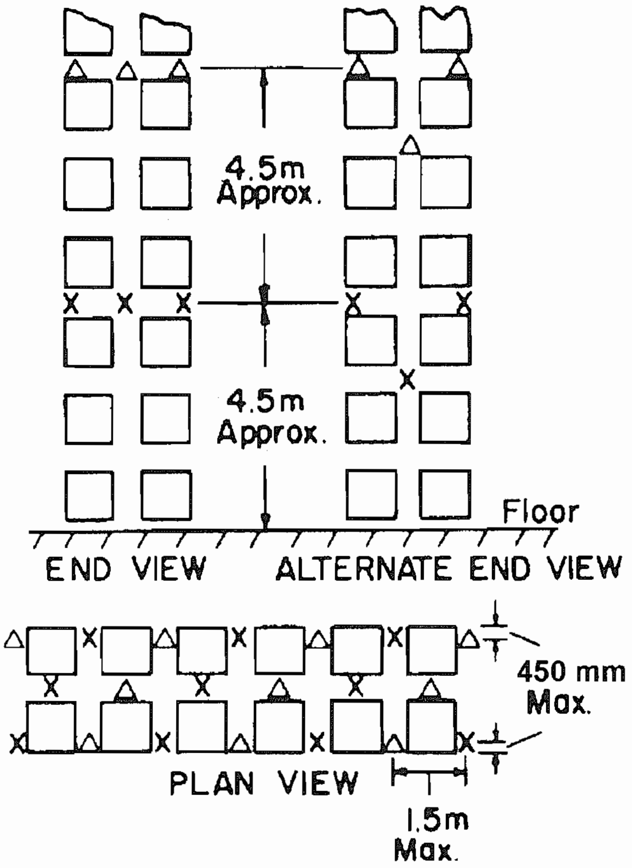
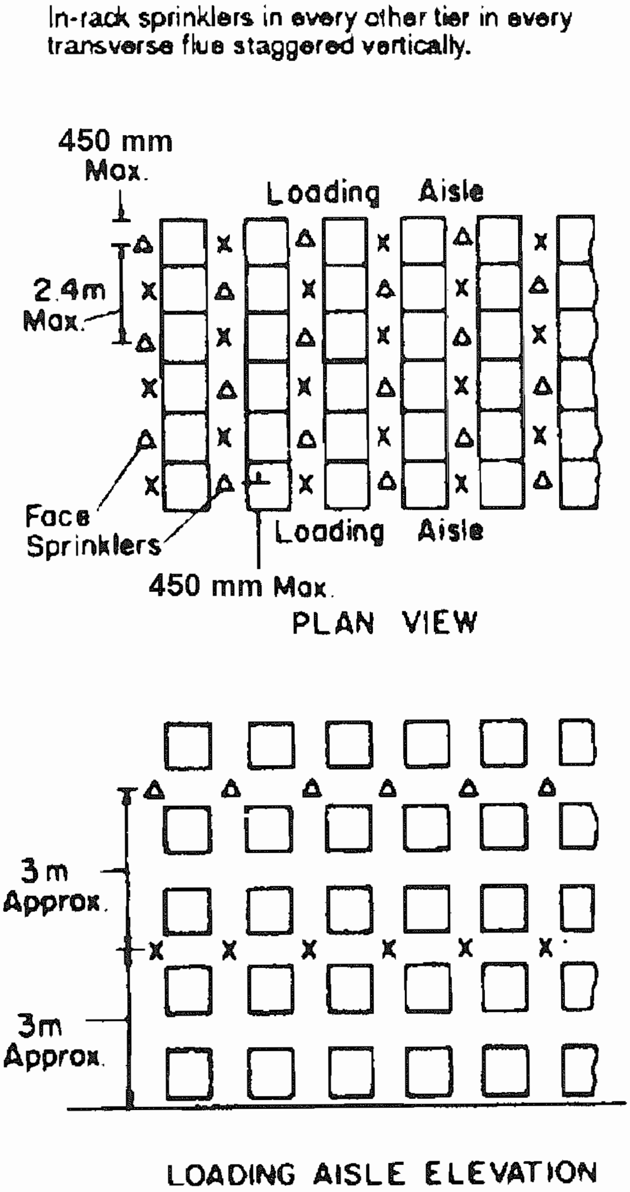


Figure 9.24(a) – On-side, double row rack, with barriers – IRS horizontal and vertical spacing



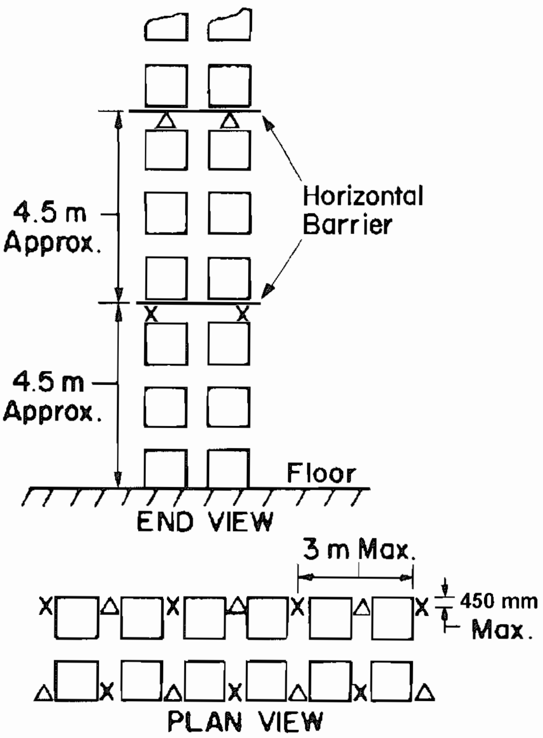
NOTE – Symbols Δ or X indicate sprinklers on vertical or horizontal stagger.

Figure 9.24(b) – On-side, double row rack, without barriers – IRS horizontal and vertical spacing



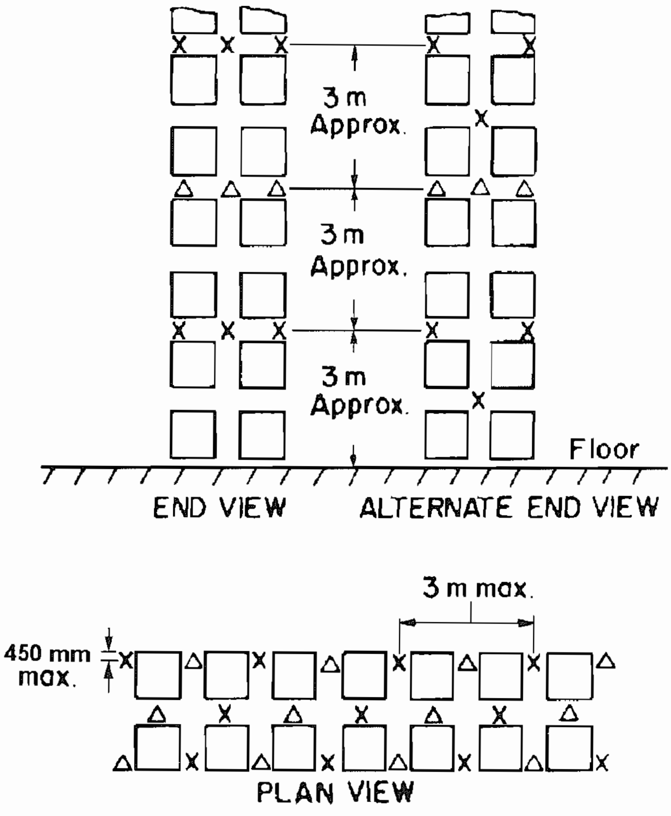
NOTE – Symbols Δ or X indicate sprinklers on vertical or horizontal stagger.

Figure 9.24(c) – On-side, multiple row rack – IRS horizontal and vertical spacing



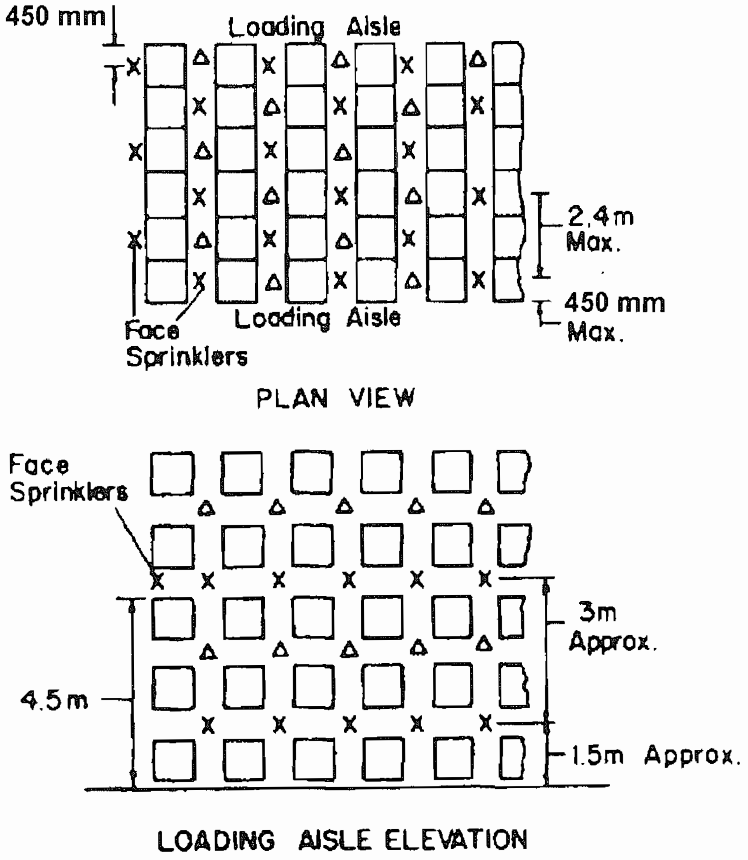
NOTE – Symbols Δ or X indicate sprinklers on vertical or horizontal stagger.

Figure 9.24(d) – On-tread, double row rack, with barriers – IRS horizontal and vertical spacing



NOTE – Symbols Δ or X indicate sprinklers on vertical or horizontal stagger.

Figure 9.24(e) – On-tread, double row rack, without barriers – IRS horizontal and vertical spacing


In-rack sprinklers in every tier in every transverse flue staggered, both horizontally and vertically

NOTE – Symbols Δ or X indicate sprinklers on vertical or horizontal stagger.

Figure 9.24(f) – On-tread, multiple row rack – IRS horizontal and vertical spacing

907.1.6 *High-expansion foam systems*

High-expansion foam systems, where required, should be designed and installed in accordance with Factory Mutual Global's Data Sheet 4-3N, or NFPA 11A.

C907.1.6

Tyre storage presents a severe fire hazard. Tyres burn rapidly, emitting intense heat and large quantities of dense smoke that hamper firefighting. Tyres are generally manufactured from synthetic compounds, carbon, oil, various additives and fabrics of steel, fibreglass, polyester, cotton, etc. The principal rubber materials used in tyres are synthetic rubbers. Heat of combustion can vary from 33 to 34 mJ/kg. Ignition temperature can vary from 371 °C to 425 °C.

The hollow toroidal shape of the tyre provides a large shielded surface area and excellent flue spaces which, combined with the material, result in a severe fire hazard. Automatic sprinklers can control fires in most tyre storages, but water demands are high.

907.1.7 *Protection of rubber tyres with control mode specific application sprinklers*

Rubber tyres shall be protected using the criteria in table 9.14(e) for control mode specific application sprinkler.

Table 9.14(e) – Control mode specific application criteria for on-side and on-tread rubber tyres

Maximum storage height (m)	**Maximum building height** (m)	**Number of sprinklers at pressure** (kPa)
7.6	9.1	20 @ 520

NOTE –

(1) Wet pipe systems only.

(2) *K* Factor 16, 140 °C pendent sprinklers to be used.

(3) Where roof slope exceeds 10°, increase the design number of sprinklers operating by 30 % i.e. 26.

907.1.8 *Protection of rubber tyres with suppression mode sprinklers*

Rubber tyres shall be protected using the criteria in table 9.14(f) for suppression mode sprinklers.

Table 9.14(f) – Suppression mode sprinklers for rubber tyre storage

Piling method	**Max. storage height** (m)	**Max. building height** (m)	**Rubber tyre storage**					
			Wet pipe, No. A.S. pressure, kPa					
			***K* factor 36, 70 °C pendent**	***K* factor 32, 70 °C pendent**	***K* factor 24, 70 °C pendent**	***K* factor 24, 70 °C upright**	***K* factor 20, 70 °C pendent**	***K* factor 20, 70 °C upright**
On-side or on-tread in palletised portable racks, open portable racks or fixed racks without solid shelves	7.6	9.1	12@100 (FM Global 12@140kPa)	DNA	12@240	12@240	12@350	12@350
On-side in palletised portable racks, open portable racks or fixed racks without solid shelves	7.6	10.7	12@170 (FM Global 12@140kPa)	DNA	12@360	12@360	12@520	12@520
Laced tyres in open portable steel racks	7.6	9.1	DNA	DNA	DNA	DNA	20@520 (see Notes 1 and 2)	DNA
On-side in palletised portable racks	7.6	12.2	DNA	DNA	12@360	DNA	12@520	DNA

NOTE –

(1) Where used in this application, ESFR protection is expected to control rather than suppress the fire.

(2) The design area shall consist of the most hydraulically demanding area of 20 sprinklers, consisting of five sprinklers on each of four ranges. The design area of operation shall be at least 149 m^2.

907.2 Roll paper storage

This clause specifies the requirements and provides necessary information and procedures for the design of sprinkler system protection of roll paper storage.

NOTE – It does not apply to the storage of rolled nonwoven fabrics, layered pulp with synthetic fillers, polyester or rayon and chemically treated rolled paper.

The decision tree shown in figure 9.25 is provided for general guidance in selecting the appropriate level of protection for high piled storage of Roll Paper. Alternative approaches using control mode specific applications and suppression mode sprinklers are provided in table 9.16(c) and tables 9.17(r) to (u).

907.2.1 *Roll paper classification*

Roll paper is classified into three grades, as follows:

(a) Lightweight Roll Paper (see 902.22);

(b) Medium weight Roll Paper (see 902.23); and

(c) Heavyweight Roll Paper (see 902.16).

C907.2.1

Fire tests and loss experience have shown that the weight or grade of paper can affect fire severity. Fires involving lightweight papers operate more sprinklers, create higher temperatures and cause significantly more damage than do fires involving heavyweight paper.

Medium weight papers can exhibit more rapid flame spread than heavyweight paper, but the fire hazard is not quite as severe as with lightweight paper.

The current trend of making paper more water resistant, in particular the heavyweight grade used to make cardboard, has resulted in increasing the burning characteristics of the paper requiring increased design densities.

907.2.2 *Reclassification by wrapping*

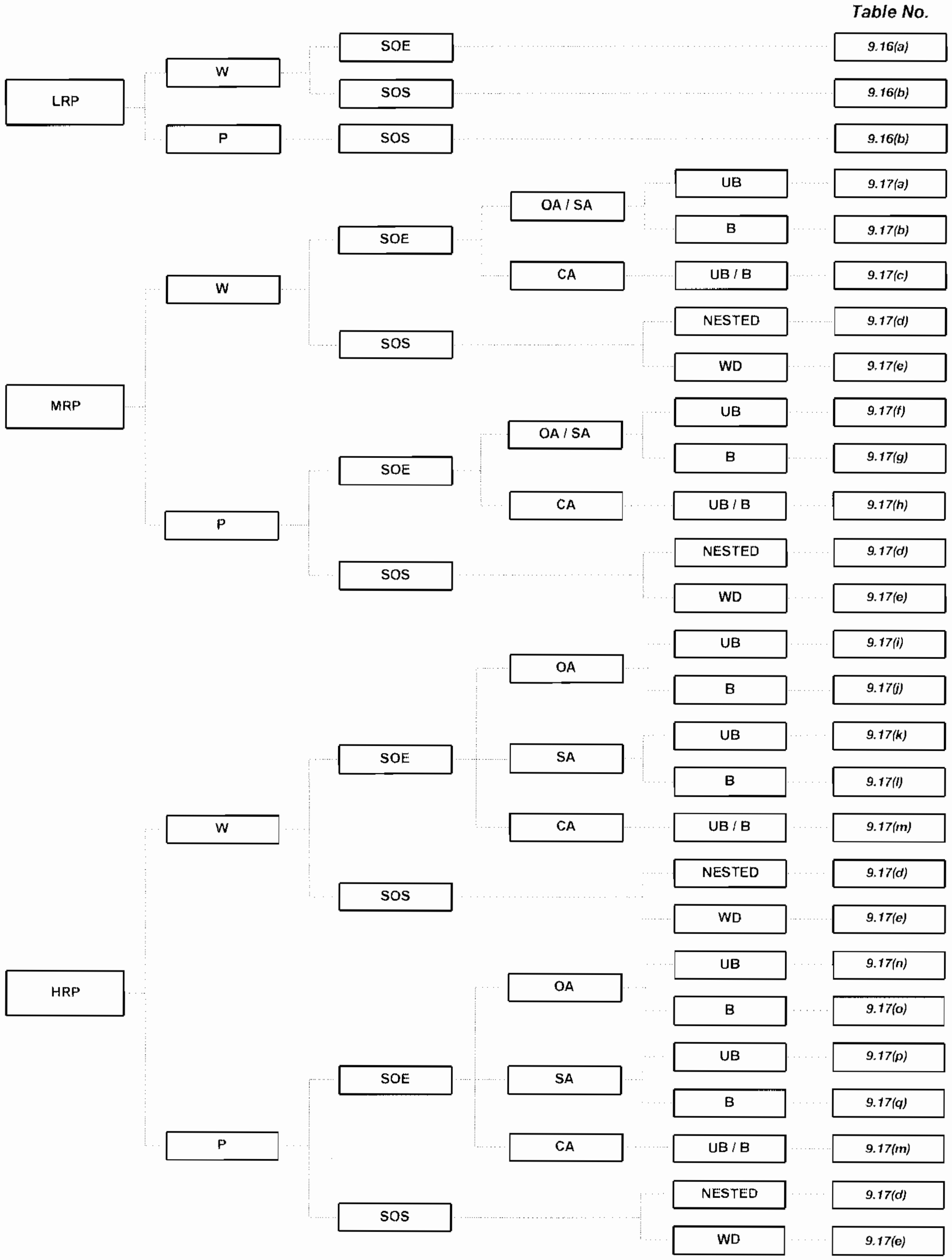
Rolls of lightweight or medium weight paper can be reclassified as heavyweight paper when one of the following methods is used:

(a) Sides and ends wrapped with a minimum of a single layer of heavyweight paper weighing at least 195 g/m^2;

(b) Sides and ends wrapped with a minimum of two layers of heavyweight paper weighing at least 98 g/m^2;

(c) Sides wrapped with a minimum of a single layer of heavyweight paper weighing at least 195 g/m^2 and banded with steel straps;

(d) Sides wrapped with a minimum of two layers of heavyweight paper weighing at least 98 g/m^2 and banded with steel straps.



KEY –

LRP – Lightweight roll paper
MRP – Mediumweight roll paper
HRP – Heavyweight roll paper
W – Wet system
P – Pre-action system
SOE – Stored on end
SOS – Stored on side

OA – Open array
SA – Standard array
CA – Closed array
UB – Unbonded
B – Bonded
MRR – Multiple row rack
WD – With dunnage

Figure 9.25 – Roll paper, design decision tree

907.2.3 *Plastic wrapped roll paper*

Plastic wrapped roll paper shall be protected in the same way as unwrapped paper. Design criteria shall be based upon the paper itself, without any adjustment for plastic wrapping. This also applies where there is a layer, or several layers of expanded plastic padding between the outer plastic layer and the paper.

907.2.4 *Special paper types*

(a) *Plastic coated paper.* The term 'plastic coated' refers to a thin coating such as that found in a milk carton. The design area shall be increased by 25 % for plastic coated heavyweight or medium weight roll paper.

(b) *Plastic laminate paper.* Plastic laminate paper consisting of paper and plastic layers susceptible to separation, shall be protected as a Category 5 commodity in accordance with the requirements of 906.

(c) *Asphalt laminated paper.* Asphalt laminated paper, consisting of two or more sheets of paper bonded together with one or more layers of asphalt, shall be protected the same as plastic coated heavyweight paper.

907.2.5 *Banded paper (see 902.2)*

Metal bands or steel baling wire applied around the circumference of roll paper reduce unwinding or peeling. Protection requirements are reduced, in many storage arrangements, if rolls are banded with metal or steel.

Where plastic bands are used, the sprinkler design criteria shall be based on the requirements for unbanded roll paper.

NOTE – Some plastic bands are black and shiny, hence, easily confused with steel bands. Plastic bands will melt and drop off in a fire condition.

907.2.6 *Storage arrangements*

Protection requirements vary in relation to roll paper storage arrangements as follows:

(a) *On-floor storage*

On-floor storage of roll paper is either on-end or on-side.

On-end storage consists of stacks of rolls in the following configurations:

(i) Standard array (see 902.40)
(ii) Open array (see 902.29)
(iii) Closed array (see 902.6).

For medium weight roll paper stored on-end, the design criteria are the same for open or standard array, and are less demanding for closed array.

For heavyweight roll paper stored on-end, the sprinkler design criteria are generally most demanding for open array and progressively less demanding for standard array and closed array, respectively.

The design criteria for lightweight roll paper stored on end are constant for all three array types.

The design criteria for on-side storage are generally less demanding than for on-end storage for all paper grades.

The design criteria for protection of on-floor, on-end and on-side storage of roll paper shall be in accordance with the requirements of tables 9.16(a) and (b), and table 9.17(a) to 9.17(q), as appropriate, (see figure 9.25).

(b) *On-floor, on-end storage using wooden pallets*

Sprinkler design criteria for on-floor, on-end storage of roll paper on wooden pallets, shall be as required for normal on-end storage in an open array arrangement.

(c) *Rack storage of medium weight and heavyweight roll paper*

Medium weight and heavyweight roll paper stored in racks shall be protected as a Category 3 commodity in accordance with the requirements of 905.12.

(d) *Axial rod storage*

Heavyweight or medium weight roll paper stored on axial rods, shall be protected as for on-end, unbanded, open array, roll paper, subject to a maximum storage height of 6.1 m.

Where the storage height exceeds 6.1 m, in-rack sprinklers shall be provided at not more than 3.7 m vertical intervals, and the design requirements for roof/ceiling sprinklers shall be based on the height of storage above the highest level of in-rack sprinklers.
In-rack sprinklers shall be as described in 904.2.1, fitted with a water shield.

Hydraulic calculations shall be based on roof/ceiling sprinklers and in-rack sprinklers operating simultaneously, generally in accordance with the requirements of 905.12.2, except as follows:

(i) When only one level of in-rack sprinklers is required, the in-rack sprinkler design shall be based on eight sprinklers operating at a minimum flow rate of 114 L/min each

(ii) When two or more levels of in-rack sprinklers are required, the in-rack sprinkler design shall be based on 14 sprinklers operating at a minimum flow rate of 114 L/min each.

907.2.7 *Mixed storage*

In locations having mixed storage or several different storage arrangements, sprinkler design criteria shall be based on the greatest storage hazard within each design area.

907.2.8 *System type*

Where there is no likelihood of freezing, systems shall be wet type.

Except in the case of lightweight roll paper stored on end, where there is a likelihood of freezing, a pre-action system shall be installed in accordance with the requirements of 903.2, except that where detection sprinklers are required the area coverage per detector shall be the same as applicable to roof/ceiling sprinklers (see 907.2.10).

NOTE –
(1) Dry systems are not acceptable.
(2) Pre-action systems with gridded pipework are not acceptable.
(3) Suppression mode sprinklers must be on a wet system.

907.2.9 *Sprinkler types and temperature ratings*

Spray type roof/ceiling sprinklers shall be in accordance with the requirements of 904.1.1 and 904.1.2, except that:

(a) Sprinklers shall have a nominal temperature rating of 141 °C; and

(b) Sprinklers shall have a nominal orifice size of 20 mm for densities greater than 12 mm/min.

In-rack sprinklers shall be in accordance with the requirements of 904.2.

907.2.10 *Area coverage and spacing of roof/ceiling sprinklers*

The area coverage per spray type roof/ceiling sprinkler shall be limited in accordance with table 9.15.

Table 9.15 – Area coverage and spacing per roof/ceiling

Nominal orifice size (mm)	**Minimum area per sprinkler,** (m^2)	**Maximum area per sprinkler** (m^2)
20	6.5	9.3
15	4.6	9.3

The distance between sprinklers shall be limited to those nominated in 904.1.5.

907.2.11 *Steel protection*

When sprinkler systems are designed and installed in accordance with 907.2, fire protection of roof or column steel is not required.

907.2.12 *Protection of lightweight paper*

Lightweight paper shall be protected in accordance with maximum storage heights and clearances set out in tables 9.16(a) to (c).

Table 9.16(a) – Lightweight roll paper, stored-on-end

Maximum storage height (m)	**rDD**	**Clearance from top of storage to roof/ceiling** (m)			
		Up to 1.5	**3**	**4.6**	**6.1**
		rDA	**rDA**	**rDA**	**rDA**
3.6	12.0	372	372	464	557
3.7	24.0	232	279	325	418
3.8	24.0	237	284	330	N/A
3.9	24.0	242	289	335	
4.0	24.0	248	294	341	
4.1	24.0	253	299	346	
4.2	24.0	258	305	351	
4.3	24.0	263	310	356	
4.4	24.0	269	315	362	
4.5	24.0	274	320	367	
4.6	24.0	279	325	372	
4.7	24.0	285	340	N/A	
4.8	24.0	291	356		
4.9	24.0	298	371		
5.0	24.0	304	387		
5.1	24.0	310	402		
5.2	24.0	316	418		
5.3	24.0	322	433		
5.4	24.0	329	449		
5.5	24.0	335	464		
5.6	24.0	341	480		
5.7	24.0	347	495		
5.8	24.0	353	511		
5.9	24.0	360	526		
6.0	24.0	366	542		
6.1	24.0	372	557		

Table 9.16(a) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet type system.

(ii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the table (see table entry notation 1).

Table 9.16(a) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the table is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. rDD – Roof/ceiling design density, mm/min.
3. rDA – Roof/ceiling design area, m^2.

Table 9.16(b) – Lightweight roll paper, stored-on-side

Maximum storage height (m)	**Maximum clearance** (m)	**rDD** (mm/min)	**Wet type system rDA** (m^2)	**Pre-action type system rDA** (m^2)
3.6	4.0	8.0	557	929
3.7	3.9	10.0	557	836
3.8	3.8	10.0	557	836
3.9	3.7	10.0	557	836
4.0	3.6	10.0	557	836
4.1	3.5	10.0	557	836
4.2	3.4	10.0	557	836
4.3	3.3	10.0	557	836
4.4	3.2	10.0	557	836
4.5	3.1	10.0	557	836
4.6	3.0	10.0	557	836
4.7	2.9	14.0	551	821
4.8	2.8	14.0	545	805
4.9	2.7	14.0	538	790
5.0	2.6	14.0	532	774
5.1	2.5	14.0	526	759
5.2	2.4	14.0	520	743
5.3	2.3	14.0	514	728
5.4	2.2	14.0	507	712
5.5	2.1	14.0	501	697
5.6	2.0	14.0	495	681
5.7	1.9	14.0	489	665
5.8	1.8	14.0	483	650
5.9	1.7	14.0	476	635
6.0	1.6	14.0	470	619
6.1	1.5	14.0	464	604

Table 9.16(b) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet type system or a pre-action system (see table entry notation 2).

(ii) Gridded pipework configurations are not permitted for pre-action systems (see 903.2).

(iii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the table (see table entry notation 1).

Table 9.16(b) entry notations (modifications and additional design requirements)

1. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. Detection Sprinklers where required for pre-action systems shall comply with the requirements of 907.2.8.
3. rDD – Roof/ceiling design density, mm/min.
4. rDA – Roof/ceiling design area, m^2.

Table 9.16(c) – Control mode specific application sprinklers for lightweight roll paper storage

Maximum storage height (m)	**Maximum building height** (m)	***K* factor** (lpm/kPa$^{0.5}$)	**Sprinkler temperature rating**	**Number of sprinklers operating @ pressure** (kPa)	**Notes**
6.1	9.1	16	70 °C or 140 °C	25 @ 520	1, 2, 3
6.1	9.1	24	70 °C or 140 °C	25 @ 240	1, 2, 3
7.6	9.1	20	70 °C	16 @ 520	1, 2, 4
7.6	12.2	20	70 °C	25 @ 520	1, 2, 4

NOTE –

(1) Acceptable storage arrangements are on-side or on-end. Paper can be banded or unbanded. Acceptable arrays are open, standard or closed.

(2) Wet pipe systems only permitted.

(3) Where roof slope exceeds 10°, increase the design number of sprinklers operating by 30 %.

(4) Use approved *K* = 20 suppression mode sprinklers only for this control mode specific application. Design and install these sprinklers in accordance with 518.

907.2.13 *Protection of medium weight/heavyweight roll paper*

Medium weight and heavyweight paper shall be protected in accordance with maximum storage heights and clearances set out in tables 9.17(a) to (u).

Table 9.17(a) – Medium weight roll paper, stored-on-end, open/standard array, unbanded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	186	186	279
3.2	13.0	186	198	291
3.4	13.5	186	209	302
3.6	14.5	186	221	314
3.8	15.0	187	233	326
4.0	16.0	198	244	337
4.2	16.5	210	256	349
4.4	17.5	221	267	360
4.6	18.0	233	279	372
4.8	19.0	239	285	378
5.0	19.5	245	291	384
5.2	20.5	251	297	390
5.4	21.0	258	304	397
5.6	22.0	264	310	403
5.8	23.0	270	316	409
6.0	23.5	276	322	415
6.2	24.0	282	328	421
6.4	24.0	289	335	428
6.6	24.0	296	342	435
6.8	24.0	303	349	442
7.0	24.0	309	355	448
7.2	24.0	316	362	455
7.4	24.0	323	369	462
7.6	24.0	329	375	468
7.8	24.0	335	381	474
8.0	24.0	340	386	479
8.2	24.0	346	392	485
8.4	24.0	352	398	491
8.6	24.0	358	404	497
8.8	24.0	363	409	502
9.0	24.0	369	415	508
9.1	24.0	372	418	511

Table 9.17(b) – Medium weight roll paper, stored-on-end, open/standard array, banded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	186	186	279
3.2	13.0	186	192	285
3.4	13.5	186	198	291
3.6	14.5	186	203	296
3.8	15.0	186	209	302
4.0	16.0	186	215	308
4.2	16.5	186	221	314
4.4	17.5	186	226	319
4.6	18.0	186	232	325
4.8	19.0	186	232	325
5.0	19.5	186	232	325
5.2	20.5	186	232	325
5.4	21.0	186	232	325
5.6	22.0	186	232	325
5.8	23.0	186	232	325
6.0	23.5	186	232	325
6.2	24.0	193	239	332
6.4	24.0	206	252	345
6.6	24.0	219	265	358
6.8	24.0	233	279	372
7.0	24.0	246	292	385
7.2	24.0	259	305	398
7.4	24.0	272	318	411
7.6	24.0	282	328	421
7.8	24.0	288	334	427
8.0	24.0	294	340	433
8.2	24.0	300	346	439
8.4	24.0	305	351	444
8.6	24.0	311	357	450
8.8	24.0	317	363	456
9.0	24.0	323	369	462
9.1	24.0	326	372	465

Table 9.17(a) and table 9.17(b) design constraints

The requirements of these tables are applicable, subject to the following design constraints:

(i) A wet type system.

(ii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the tables (see table entry notation 1).

Table 9.17(a) and table 9.17(b) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the tables is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. rDD – Roof/ceiling design density, mm/min.
3. rDA – Roof/ceiling design area, m^2.

Table 9.17(c) – Medium weight roll paper, stored-on-end, closed array, unbanded/banded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	186	186	279
3.2	12.0	186	186	279
3.4	12.0	186	186	279
3.6	12.0	186	186	279
3.8	12.0	186	186	279
4.0	12.0	186	186	279
4.2	12.0	186	186	279
4.4	12.0	186	186	279
4.6	12.0	186	186	279
4.8	13.0	186	192	285
5.0	13.5	186	198	291
5.2	14.5	186	204	297
5.4	15.0	186	211	304
5.6	16.0	186	217	310
5.8	17.0	186	223	316
6.0	17.5	186	229	322
6.2	18.5	186	232	325
6.4	19.5	186	232	325
6.6	20.0	186	232	325
6.8	21.0	186	232	325
7.0	22.0	186	232	325
7.2	22.5	186	232	325
7.4	23.5	186	232	325
7.6	24.0	189	235	328
7.8	24.0	195	241	334
8.0	24.0	201	247	340
8.2	24.0	207	253	346
8.4	24.0	212	258	351
8.6	24.0	218	264	357
8.8	24.0	224	270	363
9.0	24.0	230	276	369
9.1	24.0	233	279	372

Table 9.17(c) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A wet type system.

(ii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the table (see table entry notation 1).

Table 9.17(c) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the table is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. rDD – Roof/ceiling design density, mm/min.
3. rDA – Roof/ceiling design area, m^2.

Table 9.17(d) – Medium weight/heavyweight roll paper, stored-on-side, nested

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
1.5	6.0	186	232	325
1.6	6.0	208	254	347
1.8	6.0	252	298	391
2.0	6.0	295	341	434
2.2	6.0	339	385	478
2.4	6.0	383	429	522
2.6	6.0	427	473	566
2.8	6.0	470	516	609
3.0	6.0	514	560	653
3.2	6.0	514	560	653
3.4	6.0	514	560	653
3.6	6.0	514	560	653
3.8	6.0	514	560	653
4.0	6.0	514	560	653
4.2	6.0	514	560	653
4.4	6.0	514	560	653
4.6	6.0	514	560	653
4.8	6.5	495	541	634
5.0	6.5	477	523	616
5.2	7.0	458	504	597
5.4	7.0	439	485	578
5.6	7.5	421	467	560
5.8	7.5	402	448	541
6.0	8.0	383	429	522
6.2	8.0	379	425	518
6.4	8.0	388	434	527
6.6	8.0	397	443	536
6.8	8.0	406	452	545
7.0	8.0	415	461	554
7.2	8.0	424	470	563
7.4	8.0	433	479	572
7.6	8.0	442	488	581
7.8	8.0	451	497	590
8.0	8.0	461	507	600
8.2	8.0	471	517	610
8.4	8.0	480	526	619
8.6	8.0	490	536	629
8.8	8.0	500	546	639
9.0	8.0	509	555	648
9.1	8.0	514	560	653

Table 9.17(e) – Medium weight/ heavyweight roll paper, stored-on-side, with dunnage

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
1.5	6.0	186	232	325
1.6	6.0	208	254	347
1.8	6.0	252	298	391
2.0	6.0	295	341	434
2.2	6.0	339	385	478
2.4	6.0	383	429	522
2.6	6.0	427	473	566
2.8	6.0	470	516	609
3.0	6.0	514	560	653
3.2	6.0	514	560	653
3.4	6.0	514	560	653
3.6	6.0	514	560	653
3.8	6.0	514	560	653
4.0	6.0	514	560	653
4.2	6.0	514	560	653
4.4	6.0	514	560	653
4.6	6.0	514	560	653
4.8	6.5	495	541	634
5.0	6.5	477	523	616
5.2	7.0	458	504	597
5.4	7.0	439	485	578
5.6	7.5	421	467	560
5.8	7.5	402	448	541
6.0	8.0	383	429	522
6.2	8.0	382	428	521
6.4	8.0	398	444	537
6.6	8.0	413	459	552
6.8	8.0	429	475	568
7.0	8.0	445	491	584
7.2	8.0	460	506	599
7.4	8.0	476	522	615
7.6	8.0	492	538	631
7.8	8.0	507	553	646
8.0	8.0	522	568	661
8.2	8.0	537	583	676
8.4	8.0	552	598	691
8.6	8.0	567	613	706
8.8	8.0	582	628	721
9.0	8.0	597	643	736
9.1	8.0	604	650	743

Table 9.17(d) and table 9.17(e) design constraints

The requirements of these tables are applicable, subject to the following design constraints:

(i) A wet type system or a pre-action system (see table entry notation 2).

(ii) Gridded pipework configurations are not permitted for pre-action systems (see 903.2).

(iii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the tables (see table entry notation 1).

Table 9.17(d) and table 9.17(e) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the tables is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. Detection Sprinklers where required for pre-action systems shall comply with the requirements of 907.2.8.
3. rDD – Roof/ceiling design density, mm/min.
4. rDA – Roof/ceiling design area, m^2.

Table 9.17(f) – Medium weight roll paper, stored-on-end, open/standard array, unbanded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	372	418	511
3.2	13.0	372	418	511
3.4	13.5	372	418	511
3.6	14.5	372	418	511
3.8	15.0	372	418	511
4.0	16.0	372	418	511
4.2	16.5	372	418	511
4.4	17.5	372	418	511
4.6	18.0	372	418	511
4.8	19.0	366	412	505
5.0	19.5	360	406	499
5.2	20.5	354	400	493
5.4	21.0	347	393	486
5.6	22.0	341	387	480
5.8	23.0	335	381	474
6.0	23.5	329	375	468
6.2	24.0	329	375	468
6.4	24.0	336	382	475
6.6	24.0	342	388	481
6.8	24.0	349	395	488
7.0	24.0	356	402	495
7.2	24.0	362	408	501
7.4	24.0	369	415	508
7.6	24.0	375	421	514
7.8	24.0	381	427	520
8.0	24.0	386	432	525
8.2	24.0	392	438	531
8.4	24.0	398	444	537
8.6	24.0	404	450	543
8.8	24.0	409	455	548
9.0	24.0	415	461	554
9.1	24.0	418	464	557

Table 9.17(g) – Medium weight roll paper, stored-on-end, open/standard array, banded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	372	418	511
3.2	13.0	366	412	505
3.4	13.5	361	407	500
3.6	14.5	355	401	494
3.8	15.0	349	395	488
4.0	16.0	343	389	482
4.2	16.5	338	384	477
4.4	17.5	332	378	471
4.6	18.0	326	372	465
4.8	19.0	307	353	446
5.0	19.5	289	335	428
5.2	20.5	270	316	409
5.4	21.0	251	297	390
5.6	22.0	233	279	372
5.8	23.0	214	260	353
6.0	23.5	195	241	334
6.2	24.0	196	242	335
6.4	24.0	216	262	355
6.6	24.0	236	282	375
6.8	24.0	256	302	395
7.0	24.0	276	322	415
7.2	24.0	296	342	435
7.4	24.0	316	362	455
7.6	24.0	329	375	468
7.8	24.0	335	381	474
8.0	24.0	340	386	479
8.2	24.0	346	392	485
8.4	24.0	352	398	491
8.6	24.0	358	404	497
8.8	24.0	363	409	502
9.0	24.0	369	415	508
9.1	24.0	372	418	511

Table 9.17(f) and table 9.17(g) design constraints

The requirements of these tables are applicable, subject to the following design constraints:

(i) A pre-action system (see table entry notation 2).

(ii) Gridded pipework configurations are not permitted for pre-action systems (see 903.2).

(iii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the tables (see table entry notation 1).

Table 9.17(f) and table 9.17(g) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the tables is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. Detection Sprinklers where required for pre-action systems shall comply with the requirements of 907.2.8.
3. rDD – Roof/ceiling design density, mm/min.
4. rDA – Roof/ceiling design area, m^2.

Table 9.17(h) – Medium weight roll paper, stored-on-end, closed array, unbanded/banded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	372	418	511
3.2	12.0	372	418	511
3.4	12.0	372	418	511
3.6	12.0	372	418	511
3.8	12.0	372	418	511
4.0	12.0	372	418	511
4.2	12.0	372	418	511
4.4	12.0	372	418	511
4.6	12.0	372	418	511
4.8	13.0	366	412	505
5.0	13.5	360	406	499
5.2	14.5	354	400	493
5.4	15.0	347	393	486
5.6	16.0	341	387	480
5.8	17.0	335	381	474
6.0	17.5	329	375	468
6.2	18.5	323	369	462
6.4	19.5	316	362	455
6.6	20.0	309	355	448
6.8	21.0	303	349	442
7.0	22.0	296	342	435
7.2	22.5	289	335	428
7.4	23.5	282	328	421
7.6	24.0	282	328	421
7.8	24.0	288	334	427
8.0	24.0	294	340	433
8.2	24.0	300	346	439
8.4	24.0	305	351	444
8.6	24.0	311	357	450
8.8	24.0	317	363	456
9.0	24.0	323	369	462
9.1	24.0	326	372	465

Table 9.17(h) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A pre-action system (see table entry notation 2).

(ii) Gridded pipework configurations are not permitted for pre-action systems (see 903.2).

(iii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the table (See table entry notation 1).

Table 9.17(h) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the table is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. Detection Sprinklers where required for pre-action systems shall comply with the requirements of 907.2.8.
3. rDD –Roof/ceiling design density, mm/min.
4. rDA – Roof/ceiling design area, m^2.

Table 9.17(i) – Heavyweight roll paper, stored-on-end, open array, unbanded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	186	186	279
3.2	12.0	186	203	296
3.4	12.0	186	221	314
3.6	12.0	192	238	331
3.8	12.0	210	256	349
4.0	12.0	227	273	366
4.2	12.0	244	290	383
4.4	12.0	262	308	401
4.6	12.0	279	325	418
4.8	13.0	285	331	424
5.0	13.5	292	338	431
5.2	14.5	298	344	437
5.4	15.0	304	350	443
5.6	16.0	310	356	449
5.8	17.0	317	363	456
6.0	17.5	323	369	462
6.2	18.5	323	369	462
6.4	19.5	316	362	455
6.6	20.0	309	355	448
6.8	21.0	303	349	442
7.0	22.0	296	342	435
7.2	22.5	289	335	428
7.4	23.5	282	328	421
7.6	24.0	285	331	424
7.8	24.0	296	342	435
8.0	24.0	308	354	447
8.2	24.0	320	366	459
8.4	24.0	331	377	470
8.6	24.0	343	389	482
8.8	24.0	355	401	494
9.0	24.0	366	412	505
9.1	24.0	372	418	511

Table 9.17(j) – Heavyweight roll paper, stored-on-end, open array, banded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	186	186	279
3.2	12.0	186	198	291
3.4	12.0	186	209	302
3.6	12.0	186	221	314
3.8	12.0	187	233	326
4.0	12.0	198	244	337
4.2	12.0	210	256	349
4.4	12.0	221	267	360
4.6	12.0	233	279	372
4.8	13.0	239	285	378
5.0	13.5	245	291	384
5.2	14.5	251	297	390
5.4	15.0	258	304	397
5.6	16.0	264	310	403
5.8	17.0	270	316	409
6.0	17.5	276	322	415
6.2	18.5	276	322	415
6.4	19.5	269	315	408
6.6	20.0	263	309	402
6.8	21.0	256	302	395
7.0	22.0	249	295	388
7.2	22.5	243	289	382
7.4	23.5	236	282	375
7.6	24.0	239	285	378
7.8	24.0	250	296	389
8.0	24.0	262	308	401
8.2	24.0	274	320	413
8.4	24.0	285	331	424
8.6	24.0	297	343	436
8.8	24.0	309	355	448
9.0	24.0	320	366	459
9.1	24.0	326	372	465

Table 9.17(i) and table 9.17(j) design constraints

The requirements of these tables are applicable, subject to the following design constraints:

(i) A wet type system.

(ii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the tables (see table entry notation 1).

Table 9.17(i) and table 9.17(j) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the tables is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. rDD –Roof/ceiling design density, mm/min.
3. rDA – Roof/ceiling design area, m^2.

Table 9.17(k) – Heavyweight roll paper, stored-on-end, standard array, unbanded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	186	186	279
3.2	12.0	186	186	279
3.4	12.0	186	186	279
3.6	12.0	186	186	279
3.8	12.0	186	186	279
4.0	12.0	186	186	279
4.2	12.0	186	186	279
4.4	12.0	186	186	279
4.6	12.0	186	186	279
4.8	12.0	186	198	291
5.0	12.0	186	211	304
5.2	12.0	186	223	316
5.4	12.0	190	236	329
5.6	12.0	202	248	341
5.8	12.0	214	260	353
6.0	12.0	227	273	366
6.2	12.5	240	286	379
6.4	13.5	253	299	392
6.6	14.0	266	312	405
6.8	15.0	280	326	419
7.0	16.0	293	339	432
7.2	16.5	306	352	445
7.4	17.5	319	365	458
7.6	18.5	323	369	462
7.8	19.0	317	363	456
8.0	20.0	311	357	450
8.2	20.5	305	351	444
8.4	21.5	300	346	439
8.6	22.0	294	340	433
8.8	23.0	288	334	427
9.0	23.5	282	328	421
9.1	24.0	279	325	418

Table 9.17(l) – Heavyweight roll paper, stored-on-end, standard array, banded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	186	186	279
3.2	12.0	186	186	279
3.4	12.0	186	186	279
3.6	12.0	186	186	279
3.8	12.0	186	186	279
4.0	12.0	186	186	279
4.2	12.0	186	186	279
4.4	12.0	186	186	279
4.6	12.0	186	186	279
4.8	12.0	186	192	285
5.0	12.0	186	198	291
5.2	12.0	186	204	297
5.4	12.0	186	211	304
5.6	12.0	186	217	310
5.8	12.0	186	223	316
6.0	12.0	186	229	322
6.2	12.5	193	239	332
6.4	13.5	206	252	345
6.6	14.0	219	265	358
6.8	15.0	233	279	372
7.0	16.0	246	292	385
7.2	16.5	259	305	398
7.4	17.5	272	318	411
7.6	18.5	276	322	415
7.8	19.0	270	316	409
8.0	20.0	265	311	404
8.2	20.5	259	305	398
8.4	21.5	253	299	392
8.6	22.0	247	293	386
8.8	23.0	242	288	381
9.0	23.5	236	282	375
9.1	24.0	233	279	372

Table 9.17(k) and table 9.17(l) design constraints

The requirements of these tables are applicable, subject to the following design constraints:

(i) A wet type system.

(ii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the tables (see table entry notation 1).

Table 9.17(k) and table 9.17(l) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the tables is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. rDD – Roof/ceiling design density, mm/min.
3. rDA – Roof/ceiling design area, m^2.

Table 9.17(m) – Heavyweight roll paper, stored-on-end, closed array, unbanded/banded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	186	186	279
3.2	12.0	186	186	279
3.4	12.0	186	186	279
3.6	12.0	186	186	279
3.8	12.0	186	186	279
4.0	12.0	186	186	279
4.2	12.0	186	186	279
4.4	12.0	186	186	279
4.6	12.0	186	186	279
4.8	12.0	186	186	279
5.0	12.0	186	186	279
5.2	12.0	186	186	279
5.4	12.0	186	186	279
5.6	12.0	186	186	279
5.8	12.0	186	186	279
6.0	12.0	186	186	279
6.2	12.5	186	193	286
6.4	13.5	186	206	299
6.6	14.0	186	219	312
6.8	15.0	187	233	326
7.0	16.0	200	246	339
7.2	16.5	213	259	352
7.4	17.5	226	272	365
7.6	18.5	230	276	369
7.8	19.0	224	270	363
8.0	20.0	218	264	357
8.2	20.5	212	258	351
8.4	21.5	207	253	346
8.6	22.0	201	247	340
8.8	23.0	195	241	334
9.0	23.5	189	235	328
9.1	24.0	186	232	325

Table 9.17(m) design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) A pre-action system (see table entry notation 2).

(ii) Gridded pipework configurations are not permitted for pre-action systems (see 903.2).

(iii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the table (see table entry notation 1).

Table 9.17(m) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the table is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. Detection Sprinklers where required for pre-action systems shall comply with the requirements of 907.2.8.
3. rDD – Roof/ceiling design density, mm/min.
4. rDA – Roof/ceiling design area, m^2.

Table 9.17(n) – Heavyweight roll paper, stored-on-end, open array, unbanded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	372	418	511
3.2	12.0	390	436	529
3.4	12.0	408	454	547
3.6	12.0	425	471	564
3.8	12.0	443	489	582
4.0	12.0	461	507	600
4.2	12.0	479	525	618
4.4	12.0	496	542	635
4.6	12.0	514	560	653
4.8	13.0	501	547	640
5.0	13.5	488	534	627
5.2	14.5	476	522	615
5.4	15.0	463	509	602
5.6	16.0	450	496	589
5.8	17.0	437	483	576
6.0	17.5	424	470	563
6.2	18.5	415	461	554
6.4	19.5	408	454	547
6.6	20.0	402	448	541
6.8	21.0	395	441	534
7.0	22.0	388	434	527
7.2	22.5	382	428	521
7.4	23.5	375	421	514
7.6	24.0	375	421	514
7.8	24.0	381	427	520
8.0	24.0	386	432	525
8.2	24.0	392	438	531
8.4	24.0	398	444	537
8.6	24.0	404	450	543
8.8	24.0	409	455	548
9.0	24.0	415	461	554
9.1	24.0	418	464	557

Table 9.17(o) – Heavyweight roll paper, stored-on-end, open array, banded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	372	418	511
3.2	12.0	390	436	529
3.4	12.0	408	454	547
3.6	12.0	425	471	564
3.8	12.0	443	489	582
4.0	12.0	461	507	600
4.2	12.0	479	525	618
4.4	12.0	496	542	635
4.6	12.0	514	560	653
4.8	13.0	501	547	640
5.0	13.5	488	534	627
5.2	14.5	476	522	615
5.4	15.0	463	509	602
5.6	16.0	450	496	589
5.8	17.0	437	483	576
6.0	17.5	424	470	563
6.2	18.5	411	457	550
6.4	19.5	398	444	537
6.6	20.0	385	431	524
6.8	21.0	372	418	511
7.0	22.0	359	405	498
7.2	22.5	346	392	485
7.4	23.5	333	379	472
7.6	24.0	329	375	468
7.8	24.0	335	381	474
8.0	24.0	340	386	479
8.2	24.0	346	392	485
8.4	24.0	352	398	491
8.6	24.0	358	404	497
8.8	24.0	363	409	502
9.0	24.0	369	415	508
9.1	24.0	372	418	511

Table 9.17(n) and table 9.17(o) design constraints

The requirements of these tables are applicable, subject to the following design constraints:

(i) A pre-action system (see table entry notation 2).

(ii) Gridded pipework configurations are not permitted for pre-action systems (see 903.2).

(iii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the tables (see table entry notation 1).

Table 9.17(n) and table 9.17(o) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the table is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. Detection Sprinklers where required for pre-action systems shall comply with the requirements of 907.2.8.
3. rDD – Roof/ceiling design density, mm/min.
4. rDA – Roof/ceiling design area, m^2.

Table 9.17(p) – Heavyweight roll paper, stored-on-end, standard array, unbanded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	372	418	511
3.2	12.0	372	418	511
3.4	12.0	372	418	511
3.6	12.0	372	418	511
3.8	12.0	372	418	511
4.0	12.0	372	418	511
4.2	12.0	372	418	511
4.4	12.0	372	418	511
4.6	12.0	372	418	511
4.8	13.0	372	418	511
5.0	13.5	372	418	511
5.2	14.5	372	418	511
5.4	15.0	372	418	511
5.6	16.0	372	418	511
5.8	17.0	372	418	511
6.0	17.5	372	418	511
6.2	18.5	365	411	504
6.4	19.5	352	398	491
6.6	20.0	339	385	478
6.8	21.0	326	372	465
7.0	22.0	312	358	451
7.2	22.5	299	345	438
7.4	23.5	286	332	425
7.6	24.0	282	328	421
7.8	24.0	288	334	427
8.0	24.0	294	340	433
8.2	24.0	300	346	439
8.4	24.0	305	351	444
8.6	24.0	311	357	450
8.8	24.0	317	363	456
9.0	24.0	323	369	462
9.1	24.0	326	372	465

Table 9.17(q) – Heavyweight roll paper, stored-on-end, standard array, banded

Maximum storage height (m)	rDD	Clearance from top of storage to roof/ceiling (m)		
		Up to 1.5	3	6.1
		rDA	rDA	rDA
3.0	12.0	372	418	511
3.2	12.0	372	418	511
3.4	12.0	372	418	511
3.6	12.0	372	418	511
3.8	12.0	372	418	511
4.0	12.0	372	418	511
4.2	12.0	372	418	511
4.4	12.0	372	418	511
4.6	12.0	372	418	511
4.8	12.0	378	424	517
5.0	12.0	384	430	523
5.2	12.0	390	436	529
5.4	12.0	397	443	536
5.6	12.0	403	449	542
5.8	12.0	409	455	548
6.0	12.0	415	461	554
6.2	12.5	418	464	557
6.4	13.5	418	464	557
6.6	14.0	418	464	557
6.8	15.0	418	464	557
7.0	16.0	418	464	557
7.2	16.5	418	464	557
7.4	17.5	418	464	557
7.6	18.5	412	458	551
7.8	19.0	401	447	540
8.0	20.0	389	435	528
8.2	20.5	378	424	517
8.4	21.5	366	412	505
8.6	22.0	355	401	494
8.8	23.0	343	389	482
9.0	23.5	332	378	471
9.1	24.0	326	372	465

Table 9.17(p) and table 9.17(q) design constraints

The requirements of these tables are applicable, subject to the following design constraints:

(i) A pre-action system (See table entry notation 2).

(ii) Gridded pipework configurations are not permitted for pre-action systems (see 903.2).

(iii) A maximum clearance, from the top of storage to the underside of the roof/ceiling, as nominated in the tables (see table entry notation 1).

Table 9.17(p) and table 9.17(q) entry notations (modifications and additional design requirements)

1. Interpolation between clearances (from top of storage to roof/ceiling) given in the tables is not permitted. For clearance in excess of the stated limit for a given storage height, see 905.12.5.
2. Detection Sprinklers where required for pre-action systems shall comply with the requirements of 907.2.8.
3. rDD – Roof/ceiling design density, mm/min.
4. rDA – Roof/ceiling design area, m^2.

Table 9.17(r) – Control mode specific application criteria for medium weight paper (number of sprinklers at pressure in kPa)

Maximum storage height (m)	**Maximum building height** (m)	**Wet pipe system**		**Dry pipe system**	
		***K* factor 16 70 °C or 140 °C**	***K* factor 24 70 °C**	***K* factor 16 70 °C or 140 °C**	***K* factor 24 70 °C**
6.1	9.1	15 @ 350	15 @ 150	25 @ 350	25 @ 150

NOTE –

(1) Acceptable arrangements for on-end storage are standard or closed arrays. Paper can be banded or unbanded.

(2) Where roof slope exceeds 10°, increase the design number of sprinklers operating by 30 %.

Table 9.17(s) – Control mode specific application criteria for heavyweight paper (number of sprinklers at pressure in kPa)

Maximum storage height (m)	**Maximum building height** (m)	**Wet pipe system**		**Dry pipe system**	
		K factor 16 70 °C or 140 °C	*K* factor 24 70 °C	*K* factor 16 70 °C or 140 °C	*K* factor 24 70 °C
7.9	18.3	15 @ 340	15 @ 150	25 @ 340	25 @ 150

NOTE – Acceptable arrangements for on-end storage are standard or closed arrays. Paper can be banded or unbanded.

For the protection for storage of heavyweight roll paper maintained on-floor, on-end in an open array arrangement to 7.9 m high in buildings greater that 12.2 m high up to 18.3 m, one of the following options shall be provided:

(a) Store the paper in a standard array and apply protection as per table 9.17(s); or

(b) Reduce the floor to ceiling height to 12.2 m or less by installing a false ceiling over the top of the storage and apply protection as per table 9.17(s).

AND

Sprinklers shall be 70 °C or 140 °C nominally rated CMSA *K* = 16 sprinklers and 140 °C nominally rated CMSA *K* = 24 sprinklers.

Table 9.17(t) – Protection of medium weight paper with suppression mode sprinklers (number of sprinklers at pressure in kPa)

Storage height (m)	**Building height** (m)	***K* factor 20 pendent**	***K* factor 20 upright**	***K* factor 24 pendent**	***K* factor 24 upright**	***K* factor 36 pendent**
6.1	9.1	12 @ 350	12 @ 350	12 @ 240	12 @ 240	12 @ 140
	10.7	12 @ 520	12 @ 520	12 @ 360	12 @ 350	12 @ 210
	12.2	12 @ 520	DNA	12 @ 360	DNA	12 @ 280

NOTE – Acceptable arrangements for on-end storage are standard or closed arrays. Paper can be banded or unbanded.

Table 9.17(u) – Protection of heavyweight roll paper with suppression mode sprinklers (number of sprinklers at pressure in kPa)

Paper type	Storage height (m)	Building height (m)	*K* factor 20 pendent	*K* factor 20 upright	*K* factor 24 pendent	*K* factor 24 upright	*K* factor 36 pendent
Heavy-weight	7.6	9.1	12 @ 350	12 @ 350	12 @ 240	12 @ 240	12 @ 140
	9.1	10.7	12 @ 520	12 @ 520	12 @ 360	12 @ 350	12 @ 280
		12.2	12 @ 520	DNA	12 @ 360	DNA	12 @ 280
Plastic coated heavyweight	6.1	9.1	12 @ 340	12 @ 340	12 @ 240	12 @ 240	12 @ 140
		10.7	12 @ 520	12 @ 510	12 @ 360	12 @ 350	12 @ 280
		12.2	12 @ 520	DNA	12 @ 360	DNA	12 @ 280
NOTE – Acceptable arrangements for on-end storage are standard or closed arrays or banded open array.							

907.3 Baled fibres and waste paper storage

This clause specifies the requirements and provides necessary information and procedures for the design of standard sprinkler system protection of waste paper and baled fibres (natural and synthetic). Loose wool, fibre, paper, or bundles of flax etc, should be adequately protected, by compliance with table 9.18.

907.3.1 *Storage in racks*

Baled fibres and waste paper stored in racks shall be protected as Category 4 commodities in accordance with the requirements of 906.3 or 906.4.

907.3.2 *Solid pile storage*

Solid pile storage of baled fibres and waste paper shall be protected in accordance with the requirements of table 9.18 and the constraints as required.

Table 9.18 – Solid pile storage of waste paper and baled fibres (natural and synthetic)

Solid pile type	Storage height (m)	Maximum building height (m)	Design density (mm/min)	Design area (m^2)
Cotton, jute, hemp, sisal, flax, synthetic fibre	Up to 5	8.0	6.0	560
Wool	Up to 5	8.0	6.0	230
Waste paper	Up to 3.1	6.1	6.0	230
	Up to 4.6	7.6	8.0	250
	Up to 6.1	9.1	10.0	280
	Up to 9.1	12.2	12.0	460

Table 9.18 design constraints

The requirements of this table are applicable, subject to the following design constraints.

(i) A wet type system or pre-action system system (see table entry notation 1).
(ii) Gridded pipework configurations are not permitted for pre-action systems (see 903.2).
(iii) The installation of 141 °C sprinklers at roof/ceiling level.
(iv) A maximum clearance of 3 m from top of storage to underside of roof/ceiling (see table entry notation 2).

Table 9.18 entry notations (modifications and additional design requirements)

1. For pre-action systems multiply the specified design area by 1.3.
2. For clearance in excess of 3 m, see 905.12.5.

C907.3.2

Baled fibres and waste paper are all readily combustible, having generally similar burning characteristics, and require the same safeguards and firefighting procedures.

Fire will flash rapidly over the surfaces of bales, although somewhat more slowly over flax and wool than over the other fibres. The flash is followed by slower flame travel at the surface, tenacious burrowing into the pile between bales, and, except in high-density bales, penetration of the interiors of individual bales.

Firefighting efforts are complicated by dense smoke. The storage area should be vented.

Automatic sprinklers will prevent structural damage and, where piles are properly arranged and separated, will normally confine the fire to the initial pile. They may not prevent extensive burrowing of a shielded fire within a pile. Complete extinguishing usually requires removing smouldering bales outdoors where water can be applied sparingly without opening the bales.

Warehouses that store baled waste paper may also store loose piles of waste paper. The protection for the same height of baled waste paper will also provide adequate protection for the loose piles of waste paper.

907.3.3 *General*

The general and hydraulic requirements of 903, 904 and 905 shall apply, unless otherwise specified for Baled Fibres and waste paper storage. There are some requirements that differ from those specified in 903, 904 and 905; including the following:

(a) *System type.* Where there is no likelihood of freezing, systems shall be wet type. Where there is likelihood of freezing, a pre-action system may be installed;

(b) *Sprinkler head temperature rating.* Roof/ceiling sprinklers shall have a nominal temperature rating of 141 °C.

907.4 Hanging garments storage

This clause specifies the requirements and provides necessary information and procedures for the design of standard sprinkler system protection of hanging garments, composed of natural, synthetic or blends of natural and synthetic materials, with or without polyethylene (plastic) covers, on horizontal stationary pipe racks up to or over 4.6 m high, and on revolving vertical storage modules (carousels) up to 7.6 m high.

NOTE – Consideration should also be given to the use of control mode specific application sprinklers. FM Global's Data Sheet 8-18 provides design and installation requirements for control mode specific application sprinklers protecting hanging garment storage.

A brief description of some of the terms used throughout the requirements for hanging garments storage can be found in 902.

907.4.1 *Prerequisites to the sprinkler system design criteria*

The sprinkler design requirements of this clause apply only to the protection of hanging garment storage within buildings in which:

(a) Clearance from top of storage to sprinkler deflectors below roofs/ceilings or mezzanines, is not less than 900 mm and not more than 4.7 m. In cases where the clear distance is more than 4.7 m, a suspended ceiling or horizontal barrier is provided, installed 1 m to 3.1 m above the storage, with sprinklers installed thereunder;

(b) Partial suspended ceilings or solid mezzanines extend at least 2.4 m beyond any storage;

(c) A minimum of 2.4 m of clear space is maintained laterally between all edges of unenclosed vertical openings, (e.g. stairways or elevators) in suspended ceiling (or solid mezzanines) and any storage, and a line of sprinklers is installed along each edge, in accordance with the requirements of 907.4.2(e) and 907.4.2(f);

(d) Appropriate horizontal barriers exist above racks, or light plywood mezzanines are installed within racks, as necessary to comply with the tables and figures within this clause;

(e) Storage above horizontal barriers installed over racks is prohibited;

(f) Garment widths do not exceed 1.2 m;

(g) Aisles, between racks, are not less than 900 mm in width;

(h) A power interlock, where necessary, is provided to stop carousels at the point of normal retrieval upon operation of a sprinkler water flow alarm;

(i) All mezzanines have solid floors.

NOTE – Heat and smoke vents, if installed, should be manually operated or operated via fusible links with a temperature rating of at least 182 °C. Automatic operation of heat and smoke vents is not recommended.

907.4.2 *General*

The general and hydraulic design requirements of 903, 904 and 905 shall apply, unless otherwise specified for hanging garments storage. Due to the peculiarities of hanging garment storage, there are several requirements that differ from those specified in 904 and 905, including the following:

(a) *System type*

   (i) Where there is no danger of freezing, systems shall be wet type

   (ii) Where there is danger of freezing, a pre-action system shall be installed. Dry systems are not acceptable;

(b) *Sprinkler head types and temperature rating*

   Roof/ceiling sprinklers shall be in accordance with the requirements of 904.1.1 and 904.1.2, except that:

   (i) sprinklers shall have a nominal temperature rating of 141 °C, and

   (ii) sprinklers shall have a nominal orifice size of 20 mm for densities greater than 12 mm/min.

   In-rack sprinklers shall be in accordance with the requirements of 904.2.1, except that sprinklers installed under horizontal barriers, as described in 907.4.3, shall be spray type, having a nominal orifice size of 15 mm and a 74 °C temperature rating;

(c) *Area coverage per roof/ceiling sprinkler*

   The area coverage per roof/ceiling sprinkler shall not be less than 6.5 m^2, and shall not be greater than 9.3 m^2;

(d) *Clearance over storage*

   Clearance from top of storage to sprinklers below ceilings or mezzanines shall be at least 900 mm and shall not exceed 4.7 m for garments stored on pipe racks and not more than 3.0 m for garments stored in vertical carousels. Where these clearances are exceeded, a suspended ceiling shall be installed 1 m to 1.5 m above the storage, with sprinklers below;

(e) *Partial ceilings*

Partial ceilings shall extend at least 2.4 m beyond the perimeter of storage. Sprinklers shall be installed beneath the ceiling, including a row of sprinklers located 600 mm to 1 m (on the hanging garment storage side) from all edges of the partial ceiling, other than those abutting walls;

(f) *Mezzanines*

Mezzanines shall have solid floors and extend at least 2.4 m beyond the perimeter of storage. Sprinklers shall be installed beneath the mezzanine, including a row of sprinklers located 600 mm to 1 m (on the hanging garment storage side) from all edges of the mezzanine, other than those abutting walls.

Where vertical openings, (i.e. for stairways, elevators etc.) exist, and are not enclosed by walls, a clear space of at least 2.4 m shall be maintained laterally between the edges of each opening and any storage. Sprinklers installed beneath the mezzanine shall include a row of sprinklers 600 mm to 1 m (on the hanging garment side) from the edges of openings.

Hydraulic design shall be based on individual storage heights above and below the mezzanine. The flow demand of the sprinklers beneath the mezzanine shall not be required to be added to the flow demand of the sprinklers above, however, distribution pipes common to both levels shall be hydraulically sized for the greater of the two hydraulic demands.

907.4.3 *Hydraulic design criteria – Storage up to 4.6 m on stationary pipe racks – Option 1*

This clause describes the first of two design options for sprinkler protection of hanging garments stored up to 4.6 m high on stationary pipe racks (see 907.4.4 for an alternative option). The following apply:

(a) Horizontal barriers shall be installed above each rack, not more than 600 mm above the top of storage extending at least to the edge of storage (see figure 9.26);

(b) Sprinklers shall be installed at the roof/ceiling, hydraulically designed to provide a design density of 8 mm/min over the hydraulically most disadvantaged design area of 232 m^2;

(c) A row of sprinklers shall be installed centrally over each rack beneath the horizontal barrier. Sprinklers under the horizontal barriers shall be staggered and spaced not more than 2.4 m apart along the racks, with deflectors at least 355 mm above the top of storage. Sprinklers beneath the horizontal barriers shall be hydraulically designed to provide at least 114 L/min from each of the 12 hydraulically most disadvantaged sprinklers operating simultaneously;

(d) In the sizing of distribution pipework, the water flow required for sprinklers under the horizontal barriers shall be added to that required for the roof/ceiling sprinklers. At the points where the 'under barrier' pipework meets the roof/ceiling pipework, the respective flows shall be balanced in accordance with Part 10.

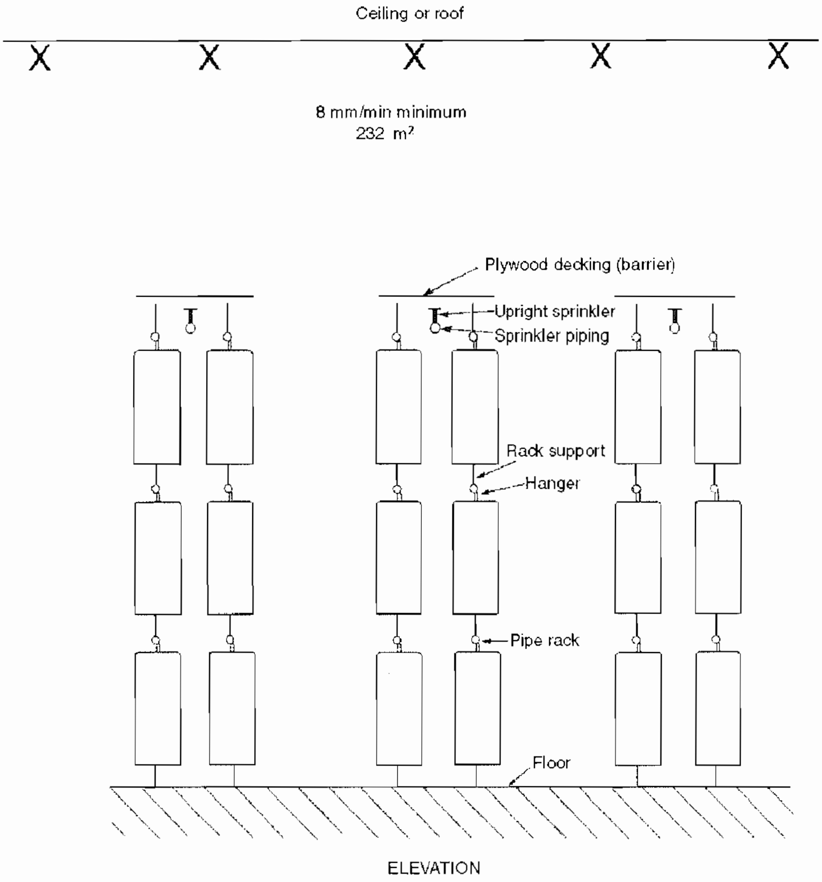


Figure 9.26 – Protection of hanging garments to 4.6 m high
(see 907.4.4 for alternative option)

907.4.4 *Hydraulic design requirements – Storage up to or over 4.6 m high on stationary pipe racks – Option 2*

This clause describes the second of two hydraulic design options for sprinkler protection of hanging garments stored up to 4.6 m high on stationary pipe racks, (see 907.4.3 for alternative option up to 4.6 m in height), and also provides the hydraulic design requirements for hanging garments stored over 4.6 m high on stationary pipe racks.

For storage up to or over 4.6 m in height, hydraulic design shall be in accordance with the requirements of table 9.19.

Table 9.19 – Protection for hanging garment storage on stationary pipe racks
(see 907.4.3 for alternative option for storage up to 4.6 m in height)

Storage height (m)	**Clearance from top of storage to roof/ceiling** (m)	**Design area** m^2	**Design density** (mm/min)
Up to 1.5	Up to 3	232	6.0
1.6 to 3.0	0.9	232	12.0
	1.0	236	
	1.2	245	
	1.4	254	
	1.6	263	
	1.8	272	
	2.0	281	
	2.2	290	
	2.4	298	
	2.6	307	
	2.8	316	
	3.0	325	
	3.1 to 4.6	511	
3.1 to 4.6	0.9	232	24.0
	1.0	236	
	1.2	245	
	1.4	254	
	1.6	263	
	1.8	272	
	2.0	281	
	2.2	290	
	2.4	298	
	2.6	307	
	2.8	316	
	3.0	325	
	3.1 to 4.6	511	
Greater than 4.6	Divide storage by solid mezzanine floors into vertical fire zones no more than 4.6 m high in accordance with 907.4.2(f). Protect storage in each vertical fire zone as outlined above.		

907.4.5 *Hydraulic design criteria – Storage up to 7.6 m in vertical carousels or similar – Option 1*

This clause describes the first of two design options, (see 907.4.6 for alternative option) for sprinkler protection of hanging garments in vertical carousels or similar vertical movable modules.

(a) Sprinklers shall be installed at the roof/ceiling, hydraulically designed to provide a design density of 24 mm/min over the hydraulically most disadvantaged design area of 352 m^2;

(b) In-rack face sprinklers shall be installed at the third tier level plus longitudinal sprinklers at the second tier and fourth tier levels, (see figures 9.27(a) and (b)). In-rack sprinklers shall be staggered vertically, spaced 2.4 m to 3 m apart horizontally and shall be hydraulically designed to provide at least 114 L/min from each of the 14 hydraulically most disadvantaged sprinklers (seven on each of two levels) operating simultaneously;

(c) In the sizing of distribution pipework, the water flow required for the in-rack sprinklers shall be added to that required for the roof/ceiling sprinklers. At the points where the in-rack sprinkler pipework meets the roof/ceiling sprinkler pipework, the respective flows shall be balanced in accordance with Part 10;

(d) In-rack sprinklers shall be located in the vertical plane so that when the conveyor is stopped at the point of normal retrieval, the sprinkler deflectors will be in line with the clear space between tiers.

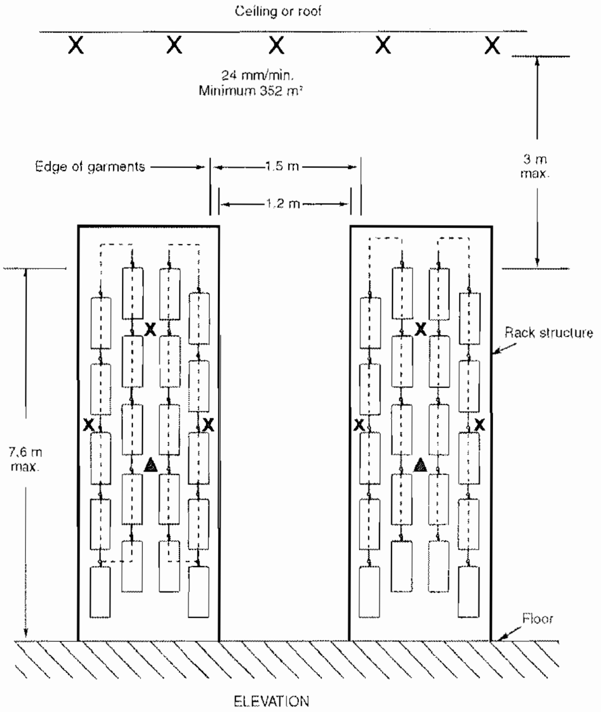


Figure 9.27(a) – Vertical carousel elevation

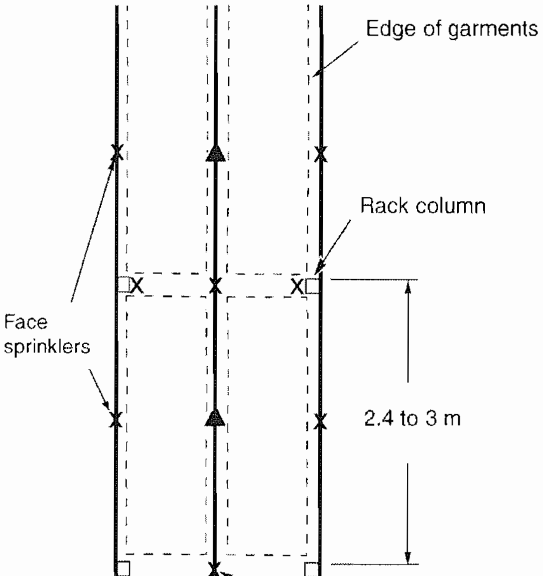


Figure 9.27(b) – Vertical carousel plan

907.4.6 *Hydraulic design criteria – Storage up to 7.6 m in vertical carousels or similar – Option 2*

This clause describes the second of two design options, (see 907.4.5 for alternative option) for sprinkler protection of hanging garments in vertical carousels or similar vertical movable modules.

(a) Sprinklers shall be installed at the roof/ceiling, hydraulically designed to provide a design density of 12 mm/min over the hydraulically most disadvantaged design area of 352 m^2.

(b) In-rack face sprinklers shall be installed at the second tier and fourth tier level plus longitudinal sprinklers at the second tier and fourth tier levels, (see figures 9.28(a) and (b)). In-rack sprinklers shall be vertically staggered, spaced 2.4 m to 3 m apart horizontally and shall be hydraulically designed to provide at least 114 L/min from each of the 14 hydraulically most disadvantaged sprinklers (seven on each of two levels) operating simultaneously.

(c) In the sizing of distribution pipework, the water flow required for the in-rack sprinklers shall be added to that required for the roof/ceiling sprinklers. At the points where the in-rack sprinkler pipework meets the roof/ceiling sprinkler pipework, the respective flows shall be balanced in accordance with Part 10.

(d) In-rack sprinklers shall be located in the vertical plane so that when the conveyor is stopped at the point of normal retrieval, the sprinkler deflectors will be in line with the clear space between tiers.

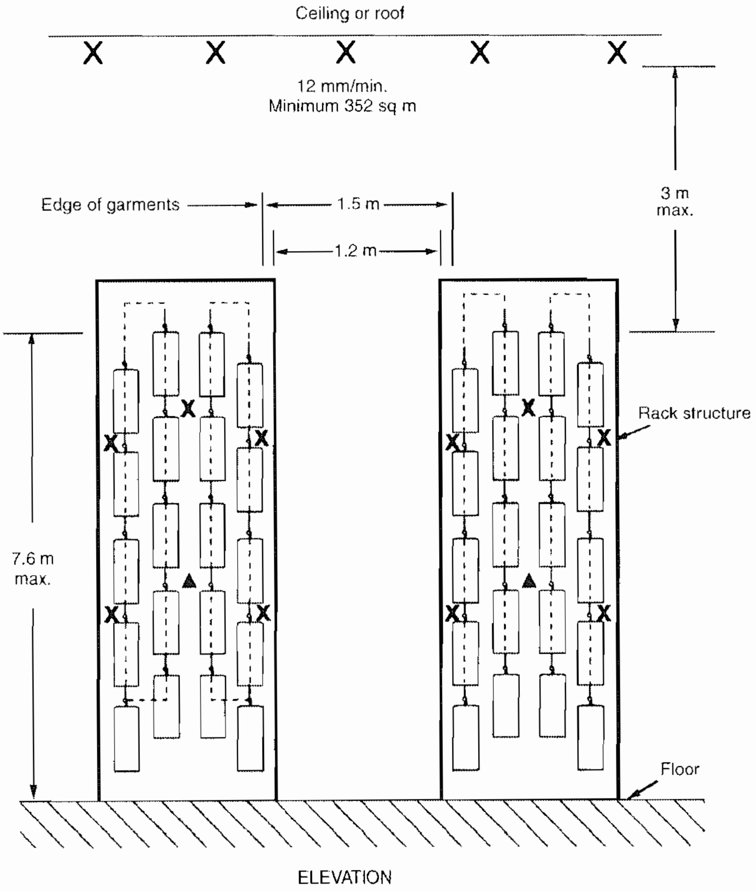


Figure 9.28(a) – Vertical carousel elevation

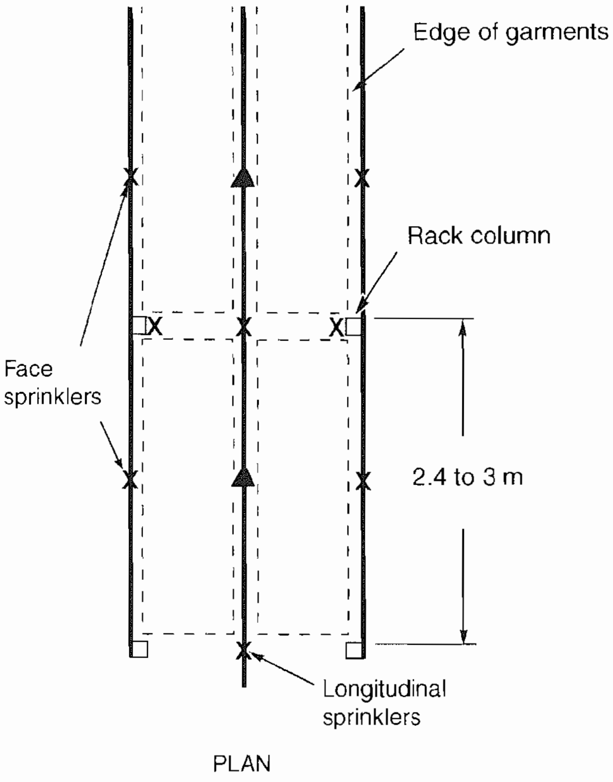


Figure 9.28(b) – Vertical carousel plan

907.5 Carpet storage

This clause specifies the requirements and provides necessary information and procedures for the design of standard sprinkler system protection of carpets made from wool, cotton, man-made fibre and synthetic blends, and applies equally to carpets having plastic or rubber backing bonded to them.

Where polyurethane, rubber foam or rubber-coated fibre underlay is stored separately (not bonded to carpet), it shall be protected in accordance with the requirements of 906.3 and 906.4 for Category 5 or Category 6 commodities, as appropriate, (see Appendix B).

C907.5 Carpet storage

General

Carpets are usually made from natural fibres (wool or cotton), man-made fibres (rayon, nylon, acrylics, etc.), or blends. Carpet backing usually consists of jute, latex, foam rubber, or foam plastic. Rolls of finished carpets are usually wrapped in laminated paper, burlap, heavy kraft paper or plastic film. Carpet rolls are usually stored in specially designed large paperboard tubes nested on floor or on racks. Smaller pieces of carpet (sometimes packed in cartons) are often solid pile, palletised, or stored in open steel racks.

Large-scale fire tests of carpet stored on racks indicated that fire developed in a vertical fan-shaped form, from floor level to the top of the rack, involving more of the storage in the upper tiers than in the lower tiers. The roof/ceiling sprinklers opened quickly, and in-rack sprinklers were effective in the tier level in which they were installed, and to a certain degree, in one or two tiers below.

Vertical barriers in racks are not a substitute for in-rack sprinklers.

Because of the smouldering nature of carpet fires, manual firefighting is extremely valuable in reducing the extent of the fire and completely extinguishing it.

Storage arrangements

Finished carpets. Although small amounts of carpet rolls and carpet pieces (door mats, runner carpet, etc.) in cartons are stored on-floor, palletised, or on racks, rolls of finished carpets are generally stored in standard carpet racks, (see figure 9.29(a)), cubicle racks, (see figure 9.29(b)), or in specially designed paperboard tubes, (see figure 9.29(c)).

907.5.1 *General design requirements*

The general design requirements of 903, 904 and 905 shall apply unless otherwise specified for carpet storage.

907.5.2 *Hydraulic design requirements*

(a) *Carpet rolls on-floor and carpet pieces*

Carpet rolls stored on-floor and carpet pieces (with or without cartons) shall be protected in accordance with the requirements of 906.2 for Category 4 commodities.

(b) *Rack and tube storage of carpet rolls*

Carpet rolls stored in racks and tubes shall be protected in accordance with the requirements of table 9.20.

Table 9.20 – Rack and tube storage of carpets

Storage arrangement	**Storage height** (m)	**In-rack sprinklers**	**Roof/ceiling design density** (mm/min)	**Roof/ceiling design area** (m^2)
Standard carpet racks	Up to 3.6 [1]	Nil [2]	12 [3]	280
		One level	8	186
	Over 3.6	Vertically every 2.7 m approx.[4]	12	186
Cubicle racks	Up to 4.6	Nil	10	280
		One level	8	186
	Over 4.6	Vertically every 4.6 m approx.[4]	12	186
Tube storage	Up to 4.6	Nil	10	280
	Over 4.6 up to 7.7	Nil	12	280

NOTE –

(1) For in-process carpet storage, the height can be increased to 4.6 m.

(2) This option is applicable only where a clear space of at least 2.5 m is provided at approximately 30 m intervals along the rack length.

(3) For lower heights, the density can be reduced to 10 mm/min.

(4) 'Approximately' indicates preferred distance, however, this can be increased by a maximum of 300 mm where necessary.

(c) *In-rack sprinklers, spacing and hydraulic design requirements*

Where in-rack sprinklers are a requirement of table 9.20, they shall be spaced vertically such that each level of in-rack sprinklers and roof/ceiling sprinklers protect approximately equal heights of storage.

In-rack sprinklers shall be in accordance with the requirement of 904.2.1.

Hydraulic design shall be based on simultaneous operation of the roof/ceiling sprinklers and the hydraulically most disadvantaged eight in-rack sprinklers on one level, with a minimum operating flowrate of 114 L/min at each in-rack sprinkler.

NOTE – Vertical barriers in racks should not be considered as a substitute for in-rack sprinklers.

907.5.3 *Protection of covered aisles*

Where storage or walkways extend over aisles, the aisles shall be protected by sprinklers positioned beneath the storage or walkways, spaced not more than 2.4 m apart horizontally along the length of the aisles. Where aisles exceed 3.7 m in width, two or more lines of sprinklers shall be provided as necessary to limit the maximum area coverage per sprinkler to 8.9 m^2.

Sprinklers protecting the aisles shall be hydraulically designed to provide for the simultaneous operation of the hydraulically most disadvantaged six sprinklers, with a minimum operating pressure of 114 L/min at each sprinkler.

The adding of the flow demand of aisle sprinklers to the flow demand of roof/ceiling sprinklers shall not be required.

907.5.4 *Rack storage*

Standard racks, (see figure 9.29(a)) are normally constructed of steel or wood frames with slatted, solid, or metal decking shelves. They have a rack-tier height of 600 mm to 1000 mm, but are usually 750 mm to 900 mm high. These carpet racks have between 4 to 10 tiers and are 2.7 m to 8.2 m high. The rack length may extend in excess of 100 m, with vertical supports located every 3.0 m to 3.7 m. Normally there are transverse flue spaces at these vertical supports. The rack depth is usually 3.7 m to 4.6 m and racks are often placed back-to-back.

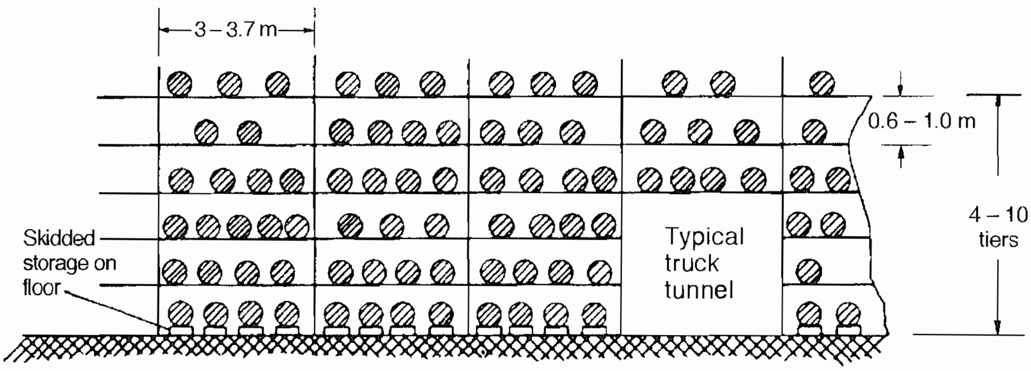


Figure 9.29(a) – Typical standard rack for carpet storage

907.5.5 *Cubicle racks*

Cubicle racks (see figure 9.29(b)) have a series of cubicles, about 800 mm x 800 mm, formed by vertical and horizontal rack members. One or two boards (150 mm to 300 mm wide) are placed on the lower horizontal rack member of each cubicle. One carpet roll is placed in each cubicle on the board(s), thus separating each roll from adjacent ones by 200 mm to 300 mm spaces.

Cubicle racks generally have transverse and longitudinal flue spaces unobstructed by carpet, wrapping, or shelving that permits sprinkler water to run down through the storage. In general, the more flue space there is, the better the penetration of water to lower storage.

The longitudinal aisles are generally 6.0 m to 9.0 m wide. The transverse aisles (sometimes called 'tunnels') are generally 3.0 m to 3.7 m wide and have storage above the aisles. The height of the aisles is usually about 3.0 m to 3.7 m, to allow clearance for forklift truck operation.

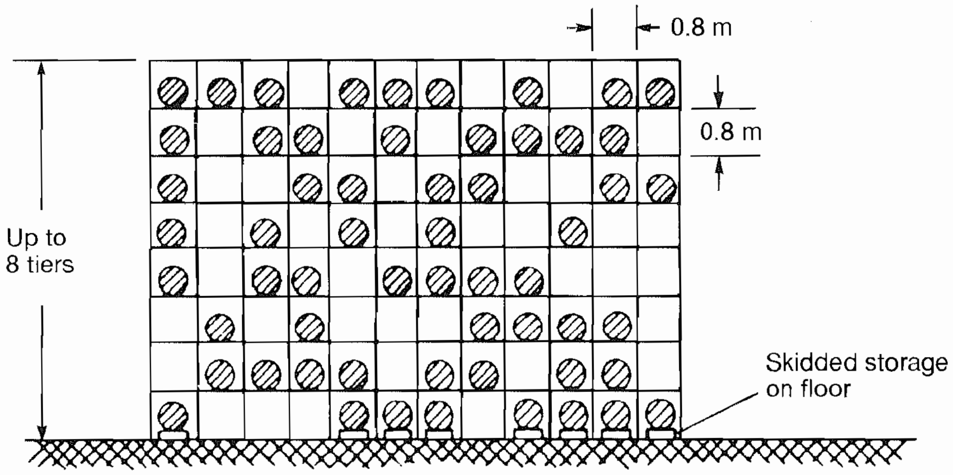


Figure 9.29(b) – Typical cubicle rack for carpet storage

907.5.6 *Tube storage*

Tube storage (see figure 9.29(c)) consists of paperboard tubes primarily nested on floor on special racks. Carpet rolls are placed in these tubes. Generally, the diameter of the tube varies from 300 mm to 1000 mm, depending on the diameter of the roll handled. The tube thickness is usually about 16 mm. The tubes may have a wax coating on the outside.

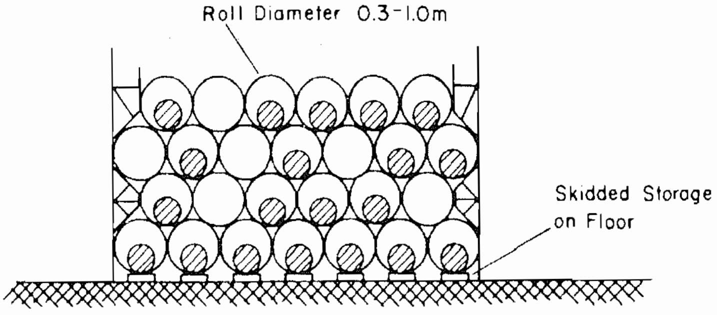


Figure 9.29(c) – Typical tube storage of carpets

907.5.7 *Unfinished carpets*

Rolls of unfinished carpets, usually about 1.2 m in diameter, are generally stored in racks two or three tiers high to an overall height of about 3.7 m.

907.6 Idle pallet storage

907.6.1 *General*

This clause specifies the requirements and provides necessary information and procedures for the design of standard sprinkler system protection of idle pallets stored within a sprinkler protected building.

Wherever possible, idle pallets should be stored externally, and as far as possible from the sprinkler-protected building. Where the clearance between the sprinkler protected building and the external idle pallet storage is less than 10 m, external sprinklers in accordance with 517, must be provided. The water supply shall be capable of allowing all external sprinklers within 10 m of pallet storage to operate simultaneously.

907.6.2 *Classification of pallets*

Idle pallets shall be classified into two groups, as follows:

(a) *Group 1*. Includes all wood and other cellulose material pallets with slatted and/or solid top and/or bottom.

(b) *Group 2*. Includes all plastic pallets, both solid and gridded deck, independent of the pallet manufacturing process, type of resin used in fabrication, or geometry of the pallet.

907.6.3 *Prerequisites to the sprinkler system design criteria*

The sprinkler design requirements of this clause apply only to the protection of idle pallet storage within buildings in which:

(a) On-floor storage of Group 2 idle pallets is located within cut-off room, limited to approximately 90 m^2 and bounded by walls or other barriers constructed to resist the spread of fire;

(b) Idle pallet storage in multiple-row drive-through type racks is prohibited;

(c) Rack storage of idle pallets is restricted to racks fitted with horizontal barriers at vertical intervals of approximately 3 m. In-rack sprinklers are to be installed under each horizontal barrier;

(d) Storage height above the topmost horizontal barrier does not exceed 3.0 m. Where Group 2 idle pallets are stored above the top tier of the rack, a horizontal barrier is to be installed 1.0 m above the top of storage, with sprinklers installed thereunder;

(e) Idle pallets in manufacturing areas are limited to the number necessary to facilitate a smooth flow of production materials for one day. Group 1 pallets are kept in single stacks not more than 1.5 m high, with a clear space of at least 1.5 m maintained between pallet stacks and other combustible material and machinery. Group 2 pallets are kept in single stacks not more than 900 mm high, with a clear space of at least 3 m maintained between pallet stacks and other combustible material and machinery;

(f) Idle pallet storage is not mixed with other commodities within racks. One rack, or the full height of a portion of one rack, is dedicated exclusively to idle pallet storage, unless the whole rack is protected in accordance with the requirements of this Standard applicable to the greatest storage hazard throughout the rack. Where a portion of one rack is dedicated to rack storage of idle pallets, a vertical barrier (see 902.43) is installed in the transverse flue space of the rack and the in-rack sprinkler protection is extended one rack bay beyond the vertical barrier;

(g) Idle pallet storage at each rack tier does not exceed 1.8 m in height, and rack tier heights are sufficient to ensure that there will be not less than 150 mm clearance between in-rack sprinkler deflectors and the top of storage immediately below;

(h) Clearance from the top of storage to roofs/ceilings or floors above, is sufficient to ensure that roof/ceiling sprinklers will be at least 900 mm clear of storage.

(i) At least 2.4 m aisle widths are maintained between racks used for idle pallet storage;

(j) In the case of Group 1 idle pallets stored on-floor at heights of 2.4 m or more, roof/ceiling sprinklers are installed at reduced spacing in accordance with the requirements of 907.6.4(c) (i);

(k) On floor storage of Group 2 idle pallets beneath overhead steel, is prohibited except as permitted in 907.6.3(e);

(l) Exposed building columns located wholly or partially within on-floor storage of Group 1 or Group 2 idle pallets, are protected by sidewall sprinklers designed and installed in accordance with the requirements of 907.6.4(d). Protection of building columns is not required where idle pallets are stored within racks and protected by in-rack sprinklers designed and installed in accordance with the requirements of 907.6.6 and 907.6.7.

NOTE – Heat and smoke vents, if installed, should be manually operated or operated via fusible links with a temperature rating of at least 182 °C. Automatic operation of heat and smoke vents is not recommended.

907.6.4 *General*

The general and hydraulic design requirements of 903, 904 and 905 shall apply unless otherwise specified for idle pallets. Due to the peculiarities of idle pallet storage, there are several requirements that differ from those specified in 904 and 905, including the following:

(a) *System type.*

  (i) Where there is no likelihood of freezing, systems shall be wet type

  (ii) Where there is a likelihood of freezing, a pre-action system may be installed (see table entry notation 1).

(b) *Sprinkler types and temperature ratings.* Spray type roof/ceiling sprinklers shall be in accordance with the requirements of 904.1.1 and 904.1.2, except that:

  (i) Sprinklers shall have a nominal temperature rating of 141 °C, and

  (ii) Sprinklers shall have a nominal orifice size of 20 mm for densities greater than 12 mm/min.

In-rack sprinklers shall be in accordance with the requirements of 904.2.1 except that they shall be quick response with a nominal orifice of 20 mm. Alternatively, control mode specific application or suppression mode sprinklers may be used.

(c) *Area coverage per spray type roof/ceiling sprinkler.*

  (i) Where *overhead* exposed steel exists above Group 1 idle pallets stored on-floor at heights of 2.4 m or more, the area coverage per roof/ceiling sprinkler shall be as follows:

    (A) 20 mm nominal orifice sprinklers: not more than 6.5 m^2

    (B) 15 mm nominal orifice sprinklers: not more than 4.7 m^2

  (ii) In all other situations, the area coverage per roof/ceiling sprinkler shall not exceed 9 m^2.

(d) *Sprinkler protection of exposed steel building columns.* Where exposed steel building columns are located wholly or partially within on-floor storage of Group 1 or Group 2 idle pallets, sprinkler protection shall be provided in accordance with the following requirements, as appropriate:

  (i) A sidewall sprinkler installed on each building column, located between 3.1 m to 4.6 m elevation, pointed towards one side of the column, and capable of providing a flow rate of at least 114 L/min. The flow rate from each sidewall sprinkler within the design area shall be added to the flow rate required for roof/ceiling sprinklers when sizing system pipework. At the point where column protection pipework meets the roof/ceiling pipework, the respective flows shall be balanced in accordance with the requirements of Part 10, or

(ii) For hollow tube or box columns provide two sidewall sprinklers, on opposite corners of the column, directed at the column located between 3.1 to 4.6 m level, capable of providing a combined flow rate of at least 114 L/min.

Protection of building columns is not required where idle pallets are stored within racks and protected by in-rack sprinklers designed and installed in accordance with the requirements of 907.6.6 and 907.6.7.

907.6.5 *Hydraulic design criteria – Limited on-floor storage of idle pallets*

The design density and design area for roof/ceiling sprinklers shall be in accordance with the requirements of table 9.21, appropriate to pallet classification and total storage height. Interpolation between storage heights given in the table is not permitted.

Table 9.21 – Protection of on-floor idle pallet storage using standard sprinklers

Type of pallet	**Storage height** (m)	**Design density** (mm/min)	**Design area** (m^2)
Group 1	Up to 1.8	8.0	186
	2.4	12.0	232
	3.7	24.0 (no exposed steel)	325
	6.1		419 or entire cut-off room, whichever is smaller
Group 2	Up to 3.7	24.0 (no exposed steel)	Entire cut-off room

907.6.6 *Hydraulic design criteria – Rack storage of idle pallets*

(a) *Roof/ceiling sprinklers.* The design density and design area for roof/ceiling sprinklers shall be in accordance with the requirements of table 9.21, as appropriate to pallet classification and height of storage above the topmost level of in-rack sprinklers. Where an additional level of in-rack sprinklers is provided in accordance with the requirements of 907.6.7(d), the design density and design area shall be 12 mm/min and 232 m^2 respectively, for 15 mm or 20 mm nominal orifice sprinklers.

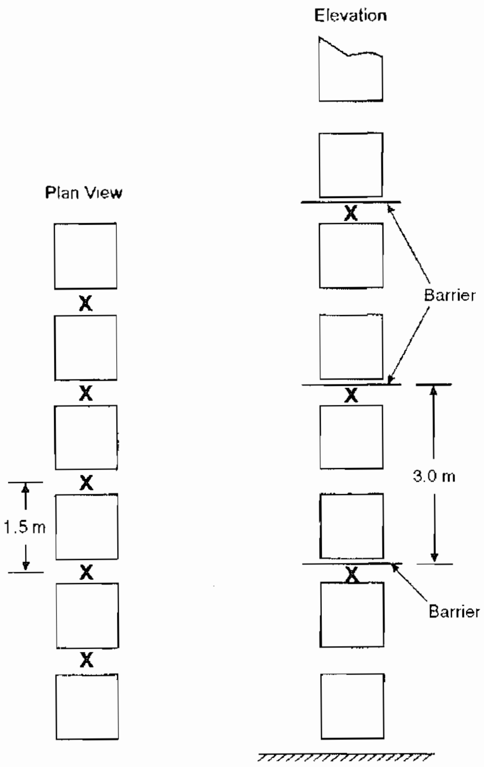
(b) *In-rack sprinklers* (see 907.6.3 for location of horizontal barriers).

(i) Racks with only one horizontal barrier. In-rack sprinklers shall be hydraulically designed based on the operation of the six hydraulically most disadvantaged in-rack sprinklers (three on each of two lines), with a minimum discharge flow rate of 215 L/min at each operating sprinkler.

(ii) Racks with more than one horizontal barrier. In-rack sprinklers shall be hydraulically designed, based on the operation of the eight hydraulically most disadvantaged in-rack sprinklers (four on each of two lines), with a minimum discharge flow rate of 215 L/min at each operating sprinkler.

907.6.7 *Location and spacing of in-rack sprinklers*

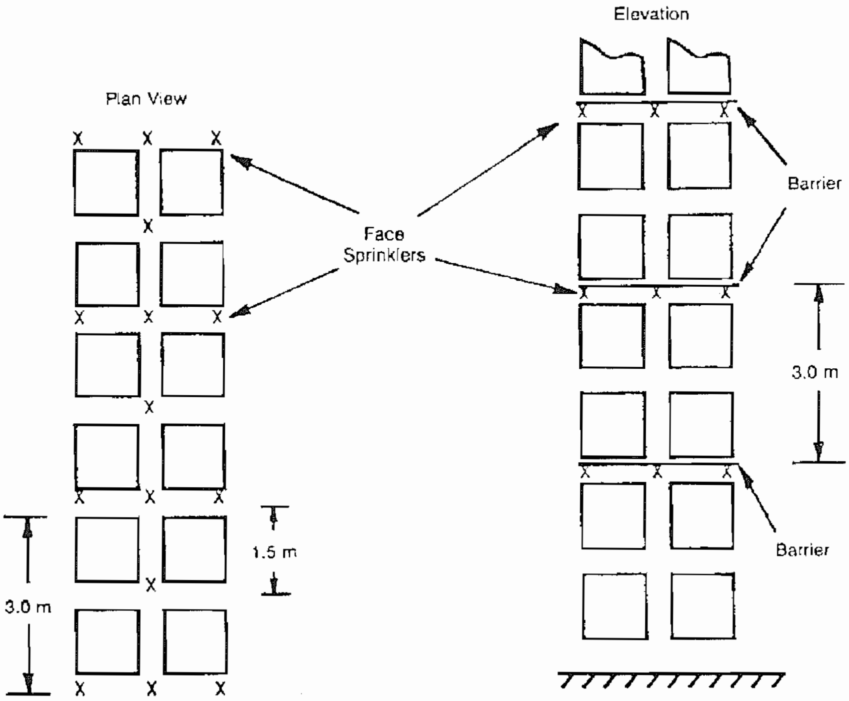
(a) *Single row racks.* One line of in-rack sprinklers shall be located down the centre of the rack at vertical intervals of approximately 3 m, and spaced approximately 1.2 m to 1.5 m apart horizontally along the length of the rack, with sprinklers installed at each transverse flue space, as depicted in figure 9.30(a).



X – In-rack sprinklers: quick response 20 mm (K = 11.5)

Figure 9.30(a) – In-rack sprinkler arrangement – Single row rack

(b) *Double row racks.* Three lines of in-rack sprinklers shall be located at each in-rack sprinkler level, one in each longitudinal flue space, and one at each rack face, at vertical intervals of approximately 3 m, as depicted in figure 9.30(b).



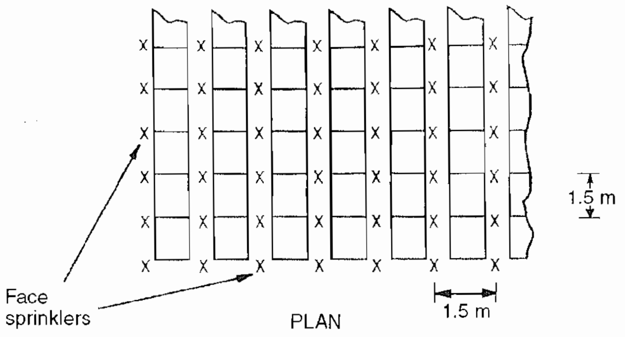
X – In-rack sprinklers: quick response 20 mm (K = 11.5)

Figure 9.30(b) – Typical horizontal barrier

Sprinklers in the longitudinal flue space shall be located at each transverse flue space, spaced approximately 1.2 m to 1.5 m apart horizontally along the length of the rack.

In-rack sprinklers at rack faces shall be located at rack uprights, spaced up to 3 m apart horizontally, except that where the rack uprights are spaced more than 3 m apart, additional face sprinklers shall be provided, centred between rack uprights.

(c) *Multiple row racks*. In-rack sprinklers shall be located at each intersection of longitudinal and transverse flue spaces, and face sprinklers shall be located at each transverse flue space, at vertical intervals of approximately 3 m, as depicted in figure 9.30(c).



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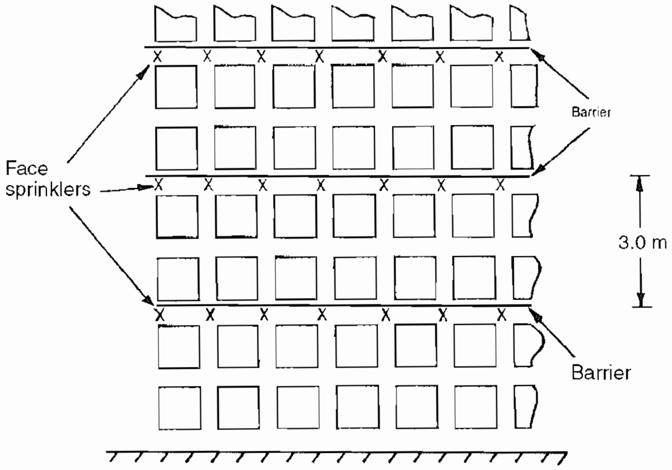


X – in-rack sprinklers, quick-response 20 mm (k = 11.5)

ELEVATION

Figure 9.30(c) – In-rack sprinkler arrangement – Multiple row rack

(d) For all types of racks (except multiple row drive-through type racks, (see 907.6.3(b)), where Group 2 idle pallets are stored above the top tier of the rack, an additional level of in-rack sprinklers shall be installed beneath the horizontal barrier provided in compliance with 907.6.3(d). The number of lines and spacing of in-rack sprinklers shall be appropriate to the type of rack, as described in (a), (b) and (c) above.

907.6.8 *Protection of Group 1 pallets with control mode specific application sprinklers*

Group 1 pallets in rack and on floor shall be protected with control mode specific application Sprinklers in accordance with the table 9.22.

Table 9.22 – Control mode specific application criteria for Group 1 idle pallets in rack or on floor (Number of K = 16 sprinklers at pressure in kPa)

Maximum storage height (m)	**Maximum building height** (m)	**Wet pipe system**	**Dry pipe system**
6.1	9.1	15 @ 170	25 @ 170

907.6.9 *Protection of idle pallets with suppression mode sprinklers*

Idle pallets shall be protected with suppression mode sprinklers in accordance with tables 9.23(a) and 9.23(b).

Table 9.23(a) – Suppression mode sprinklers for idle pallet storage Group 1 or Group 2 in-rack and Group 2 on floor

Maximum storage height (m)	Maximum building height (m)	Idle pallet storage Group 1 or Group 2 in-rack and Group 2 on floor					
		Wet pipe, No. A.S. pressure, kPa					
		K factor 36, 70 °C pendent	*K* factor 32, 70 °C pendent	*K* factor 24, 70 °C pendent	*K* factor 24, 70 °C upright	*K* factor 20, 70 °C pendent	*K* factor 20, 70 °C upright
10.7	12.2	12@350	DNA	12@360	DNA	12@520	DNA
7.6	9.7	12@350	DNA	12@290	DNA	12@410	DNA
7.6	9.2	12@350	DNA	12@240	DNA	12@350	DNA

Table 9.23(b) – Suppression mode sprinklers for idle pallet storage Group 1 on floor

Maximum storage height (m)	Maximum building height (m)	Idle pallet storage Group 1 on floor					
		Wet pipe, No. A.S. pressure, kPa					
		K factor 36, 70 °C pendent	*K* factor 31, 70 °C pendent	*K* factor 23.5, 70 °C pendent	*K* factor 23.5, 70 °C upright	*K* factor 20, 70 °C pendent	*K* factor 20, 70 °C upright
10.7	12.2	12@350	DNA	12@360	DNA	12@520	DNA
6.1	10.7	12@350	DNA	12@360	12@360	12@520	520
7.6	9.7	12@350	DNA	12@290	DNA	12@410	410
6.1	9.7	12@350	DNA	12@290	12@290	12@410	410
7.6	9.1	12@350	DNA	12@240	DNA	12@350	350
6.1	9.1	12@350	DNA	12@240	12@240	12@350	350

907.7 Aerosols storage

907.7.1 *General*

This clause specifies the requirements and provides the necessary information and procedures for the design of standard sprinkler system protection of Level 1, 2 and 3 Aerosol products packaged in cartons.

NOTE –

(1) Consideration should also be given to the use of control mode specific application sprinklers or suppression mode sprinklers. Factory Mutual Global's Loss Prevention Data 7-31 provides information for control mode specific application and suppression mode sprinklers protecting aerosol products.

(2) Protection criteria is not available for uncartoned aerosol storage, however, small quantities of uncartoned aerosol products on display in selling areas are not considered to be an unusual fire hazard in sprinkler-protected buildings.

907.7.2 *Aerosol hazard classification*

Aerosol products are classified into three hazard levels by calculating the sum of the chemical heat of combustion for the constituent components of the aerosol product (e.g. propellant, liquid products, etc.) multiplied by their weight fraction. Hazard classification calculation methods are described in Appendix K1.

Where product composition is not known and test results are not available for a particular aerosol product, it shall be classified as Level 3.

907.7.3 *Mixed storage*

Where storage of aerosol products incorporates a mixture of product hazard classification, the sprinkler design criteria shall be appropriate to the most hazardous class of product present.

907.7.4 *Prerequisites to the sprinkler system design requirements*

The effectiveness of these sprinkler design requirements is subject to the prerequisites as detailed in Appendix K2.

907.7.5 *System type*

(a) *Level 1 Aerosols*

Where:

(i) There is no likelihood of freezing, systems shall be wet type

(ii) There is a likelihood of freezing, a pre-action system shall be installed in accordance with the requirements of 903.2;

NOTE – Dry pipe systems, and pre-action systems with gridded pipework, are not acceptable.

(b) *Level 2 Aerosols*

Where:

(i) There is no likelihood of freezing, systems shall be wet type

(ii) There is a likelihood of freezing, a pre-action system shall be installed in accordance with the requirements of 903.2, except that the area coverage of detector sprinklers, where required, shall be the same as applicable to roof/ceiling sprinklers (see 302.4);

NOTE –
(1) Dry systems are not acceptable.
(2) Pre-action systems with gridded pipework are not acceptable.

(c) *Level 3 Aerosols.*

Systems shall be wet type.

NOTE – Pre-action systems and dry systems are not acceptable.

907.7.6 *Sprinkler types and temperature ratings*

Roof/ceiling sprinklers shall be in accordance with the requirements of 904.1.1 and 904.1.2 for categorised commodities, except that:

(a) Sprinklers shall have a nominal temperature rating of 141 °C; and

(b) Sprinklers shall have a nominal orifice size of 20 mm for densities greater than 12 mm/min.

In-rack sprinklers shall be in accordance with the requirements of 904.2.

907.7.7 *Area coverage per sprinkler*

The area of coverage per roof/ceiling sprinkler shall be not less than 6.5 m^2 and not greater than 9 m^2.

The area of coverage for IRS within multiple-row rack storage of Level 2 aerosols shall not exceed 7.5 m^2.

Multiple-row rack storage of Level 3 aerosols is not permitted (see Appendix K, clause K2.4(e)).

907.7.8 *Spacing of sprinklers*

The spacing of roof/ceiling sprinklers shall be not less than 1.8 m and not greater than 3.7 m.

In-rack sprinkler horizontal spacing shall not exceed 2.4 m.

907.7.9 *Solid pile and palletised sprinkler design requirements*

Level 1 aerosols shall be protected as a Category 3 commodity, (see 903, 904 and 905).

Level 2 and 3 aerosols, subject to the design prerequisites of Appendix K2.2, shall be protected in accordance with the requirements of table 9.24.

907.7.10 *In-rack sprinkler design requirements – Level 1 aerosols*

Level 1 Aerosols shall be protected as a Category 3 commodity, (see 904.2 and 905).

907.7.11 *In-rack sprinkler design requirements – Level 2 aerosols*

Where:

(a) A dedicated storage area is provided, as described in Appendix K2.3, in-rack sprinklers shall be installed beneath every rack tier of every rack located within the dedicated area. This shall also apply when extending the in-rack sprinklers into adjoining areas, as necessary when Method 3 is used to define the dedicated area;

(b) Horizontal barriers are provided, as described in Appendix K2.3(f), an additional level of in-rack sprinklers shall be installed beneath the barriers;

(c) There are multiple-row racks, the in-rack sprinklers shall be staggered vertically and horizontally. When the distance between the uppermost level of in-rack sprinklers and the top of storage exceeds 1.5 m, face sprinklers shall be installed at approximately 4.6 m vertical intervals, staggered horizontally. Examples of acceptable arrangements are shown in figures 9.31(a) and (b);

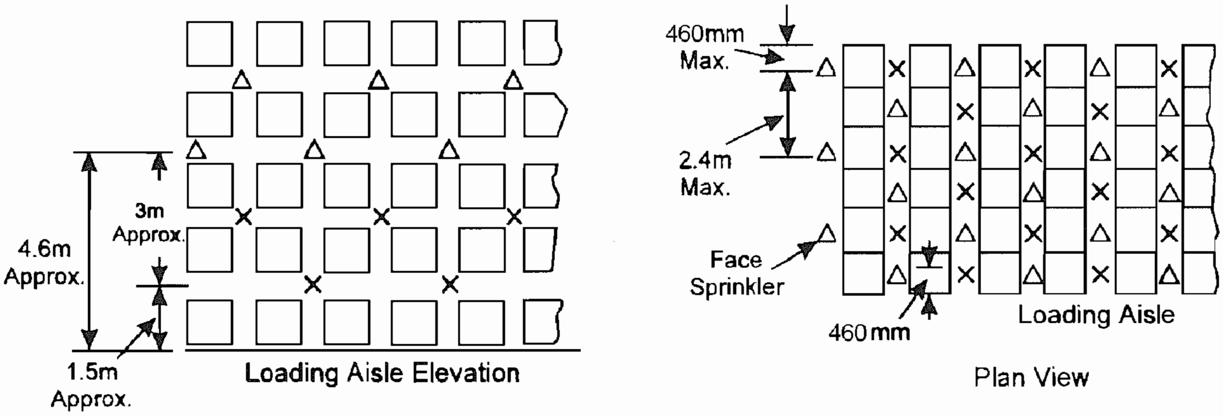


Figure 9.31(a) – Multiple row racks, level 2 aerosols

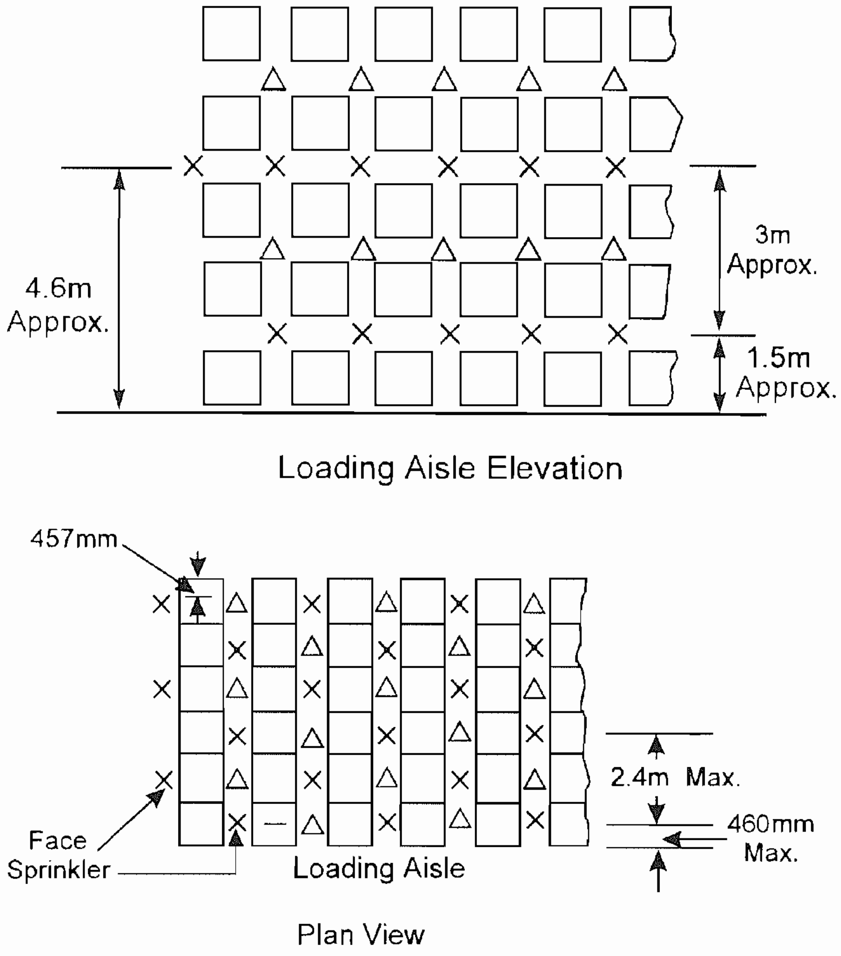


Figure 9.31(b) – Multiple row racks, level 2 aerosols

(d) There are single-row racks and double-row racks with aisles less than 1.2 m wide shall be treated as multiple-row racks;

(e) There are automated warehouses, in-rack sprinklers shall be installed above storage in every rack tier where aerosols are stored, (see Appendix K2.3(e));

(f) There are small quantities of Level 2 aerosol products (up to six pallets) and within picking areas, in-rack sprinklers shall be installed above the storage on the first and second rack tiers, (see Appendix K2.3(g)).

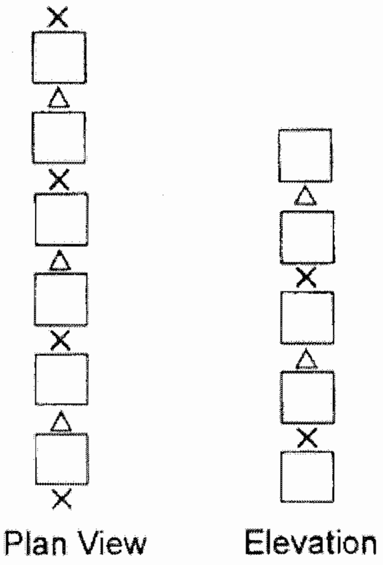
907.7.12 *In-rack sprinkler design requirements – Level 3 aerosols*

In double-row racks, in-rack sprinklers shall be located in the longitudinal flue space beneath every rack tier, together with face sprinklers on each side of the racks.

Face sprinklers on one side of a rack shall be staggered with those on the opposite side.

When horizontal barriers are provided, as described in K2.4(f), an additional level of in-rack sprinklers and an additional level of face sprinklers shall be installed beneath the barriers.

Face sprinklers may be omitted from single-row racks (see figure 9.32).



NOTE – Symbols Δ or X indicate sprinklers on vertical or horizontal stagger.

Figure 9.32 – In-rack sprinkler arrangement, single row racks

907.7.13 *Picking areas – Level 3 aerosols* (see Appendix K2.4(h))

(a) In double-row racks, face and longitudinal in-rack sprinklers shall be installed above storage in the first and second rack tiers. Face sprinklers shall be installed on both sides of the rack. The sprinklers shall be staggered horizontally and vertically.

(b) In single-row racks, a line of in-rack sprinklers shall be provided above storage in the first and second tiers and shall be staggered vertically. Face sprinklers shall be installed above storage in the second tier of the first row of racks on both sides of the aerosol storage.

(c) In flow-through racks not more than 2.4 m deep, two lines of in-rack sprinklers shall be installed at or near the 1.8 m level. Where racks are deeper than 2.4 m, a third line of in-rack sprinklers shall be installed.

Multiple-row rack storage of level 3 aerosols is not permitted, (see Appendix K).

907.7.14 *Roof/ceiling sprinklers hydraulic design*

Roof/ceiling sprinkler pipework shall be hydraulically designed to provide the design density over the design area, in accordance with the requirements of table 9.24, at the hydraulically most unfavourable location within each design area.

Table 9.24 – Roof/ceiling hydraulic design requirements

Palletised(i), solid pile(i) and In-process non-rack storage(ii), not more than one pallet level high			
Aerosol classification	**Design density** (mm/min)	**Design area** (m^2)	**Clearance from top of storage to roof/ceiling** (m)
Level 2	12	230	6.1
Level 3	24	230	4.6
Rack storage			
Aerosol classification	**Design density** (mm/min)	**Design area** (m^2)	**Clearance from top of storage to roof/ceiling** (m)
Level 2	12	230	3.0
Level 3	12	230	1.5
	24	140	1.6
	24	151	1.8
	24	163	2.0
	24	174	2.2
	24	185	2.4
	24	197	2.6
	24	208	2.8
	24	219	3.0
	24	231	3.2
	24	242	3.4
	24	253	3.6
	24	265	3.8
	24	276	4.0
	24	287	4.2
	24	299	4.4
	24	310	4.6

Table 9.24 design constraints

The requirements of this table are applicable, subject to the following design constraints:

(i) See Appendix K2.2 for design prerequisites for palletised and solid pile aerosols storage.

(ii) In-process non-rack storage is restricted to not more that six pallets.

907.7.15 *In-rack sprinklers hydraulic design*

In-rack sprinkler pipework shall be hydraulically designed to provide at least 114 L/min. from each of the following number of sprinklers operating simultaneously at the hydraulically most unfavourable location within the design area:

(a) 8 sprinklers – if only one level of in-rack sprinklers installed;

(b) 6 sprinklers – on each of 2 levels if two levels of IRS installed;

(c) 6 sprinklers – on each of 3 levels if three levels of IRS installed.

In the sizing of distribution pipework, the water flow required by the in-rack sprinklers shall be added to that required by the roof/ceiling sprinklers. At the points where the in-rack pipework meets the roof/ceiling pipework, the respective flows shall be balanced in accordance with the requirements in Part 10.

907.7.16 *Steel protection*

When sprinkler systems are designed and installed in accordance with 907.7, fire protection of roof or column steel is not required.

907.7.17 *Aerosol warning signs*

Aerosol Warning Signs of the type specificed and complying with Appendix L shall be provided to the satisfaction of a Sprinkler System Certifier (SSC).

907.8 Distilled spirits storage

This clause specifies the requirements and provides the necessary information and procedures for the design of standard sprinkler system protection of distilled spirits 75 % by volume (150 % proof) or less in wood or metal barrels, and 50 % by volume (100 % proof) or less in glass or polyethylene terephthalate (PET) plastic bottles.

NOTE – It may be possible to protect some distilled spirits stored exclusively in metal containers, to less stringent sprinkler design criteria, subject to compliance with requirements for protection of flammable liquids, (see 901).

Storage of alcoholic beverages up to 20 % by volume (40 % proof) shall be protected as a Category 1 or 2 commodity as appropriate, (see Appendix B).

Distilled spirits greater than 50 % by volume (100 % proof) stored in bottles, shall be considered as flammable liquids, (see 901).

907.8.1 *Prerequisites to the sprinkler system design criteria*

The sprinkler design requirements of this are suitable for the protection of distilled spirits storage within buildings in which the following apply:

(a) Drainage is provided sufficient to ensure that burning liquids will not pass under other storage;

(b) Barrel warehouses are used exclusively for liquor storage, with no process operations or general storage contained therein;

(c) Extra high hazard storage, such as storage of spirits in metal drums, is kept out of distilled spirits warehouses;

(d) Self-supporting rack structures for barrel storage are structurally sound and suitable and are inspected frequently for evidence of structural movement or instability, particularly after any large-scale loading or removal operations;

(e) A clearance of at least 500 mm is maintained between the top of storage and the roof/ceiling where barrels are stored on pallets and in racks;

(f) A clearance of at least 950 mm is maintained between the top of storage and the roof/ceiling where cased glass or PET bottles are stored on pallets and in racks;

(g) Clearance between the top of storage and the roof/ceiling does not exceed 6.1 m. A suspended ceiling or horizontal barriers, is installed 950 mm to 3.1 m above storage, with sprinklers installed thereunder, where necessary to achieve this;

(h) A clearance of at least 150 mm is maintained between the top of in-rack storage and in-rack sprinkler deflectors.

NOTE – Heat and smoke vents, if installed, should be manually operated or operated via fusible links with a temperature rating of at least 182 °C. Automatic operation of heat and smoke vents is not recommended.

907.8.2 *General*

The general design and hydraulic requirements of 903, 904 and 905 shall apply unless otherwise specified in 907.8.

907.8.3 *System type*

Where there is no likelihood of freezing, systems shall be wet type.

Where there is a likelihood of freezing, a pre-action type system shall be installed in accordance with the requirements of 903.2.

NOTE – Gridded pipework arrangements are not permitted in pre-action systems, see 903.2.

907.8.4 *Sprinkler types and temperature rating*

Roof/ceiling sprinklers shall be in accordance with the requirements of 904.1.1 and 904.1.2, except that:

(a) Sprinklers shall have a nominal temperature rating of 141 °C; and

(b) Sprinklers shall have a nominal orifice size of 20 mm for densities greater than 12 mm/min.

In-rack sprinklers shall be in accordance with the requirements of 904.2.1.

907.8.5 *Area of coverage per sprinkler*

The area coverage per roof/ceiling sprinkler shall be limited to the following:

(a) 20 mm nominal orifice – Minimum 6.5 m^2 – Maximum 9.0 m^2;

(b) 15 mm nominal orifice – Minimum 4.6 m^2 – Maximum 9.0 m^2.

The area coverage per in-rack sprinkler in multiple-row racks shall not exceed 7.5 m^2.

907.8.6 *Clearance*

Clearance between the storage of distilled spirits and the roof/ceiling shall be in accordance with the following requirements:

(a) For barrel storage on pallets and in racks, a clearance of at least 500 mm shall be maintained between top of storage and the roof/ceiling;

(b) For cased glass bottle storage, a clearance of at least 1 m shall be maintained between top of storage and the roof/ceiling;

(c) A clearance of at least 150 mm shall be maintained between top of in-rack storage and in-rack sprinkler deflectors;

(d) When clearance between top of storage and roof/ceiling exceeds 6.1 m, a horizontal barrier or suspended ceiling shall be installed 1 m to 3.1 m above storage, with sprinklers installed thereunder.

907.8.7 *Roof/ceiling sprinkler hydraulic design*

Design requirements for hydraulics in roof/ceiling areas shall be as follows:

(a) *Palletised barrel storage of distilled spirits*

Roof/ceiling sprinkler pipework shall be hydraulically designed to provide the design density over the design area, in accordance with the requirements of table 9.25(a). Systems shall be capable of meeting both design points nominated in table 9.25(a), except that the second design point is not applicable to wet systems protecting palletised barrel storage of four or less barrels in height;

Table 9.25(a) – Palletised barrel storage up to six barrels high

Design point	System type	Design density (mm/min)	Design area (m^2)
1	Wet	14	372
	Pre-action	14	372
2	Wet	8	929
	Pre-action	8	1162

(b) *Glass bottle case storage of distilled spirits*

Roof/ceiling sprinkler pipework shall be hydraulically designed to provide the design density over the design area, in accordance with the requirements of table 9.25(b).

For pre-action systems, the design area shall be increased by 30 %.

No increases are necessary for plastic-wrapped pallet loads;

Table 9.25(b) – Case goods storage – Palletised or solid pile

Storage height	Design density (mm/min)	Design area (m^2)
6.1	12.0	186
6.3	12.5	
6.5	13.0	
6.7	13.5	
6.9	14.0	
7.1	15.0	
7.3	15.5	
7.5	16.0	

(c) *PET bottles case storage of distilled spirits*

Case goods storage of distilled spirits (100 % proof or less) in PET bottles shall be protected as a Category 4 commodity, (see 904 and 905);

(d) *Barrels of distilled spirits in racks*

Roof/ceiling sprinkler pipework shall be hydraulically designed to provide the design density over the design area, in accordance with the requirements of tables 9.25(c) and 9.25(d).

For pre-action systems, the design area shall be increased by 30 %.

Table 9.25(c) – Single row or double row rack storage of barrels

Protection alternative	Storage height barrels	Design density (mm/min)	Design area (m^2)
Without in-rack sprinklers	Up to 12	14	278
With in-rack sprinklers:			
Method A	No limit	14	232
Method B	No limit	14	232
Method C	Up to 15	14	232
	from 16 to 18	20	232

Table 9.25(d) – Multiple row rack storage of barrels

Protection alternative	Storage height barrels	Design density (mm/min)	Design area (m^2)
Without in-rack sprinklers	Up to 6	14	278
With in-rack sprinklers	No limit	14	232

907.8.8 *Location and hydraulic design of in-rack sprinklers*

In-rack sprinklers shall be located and designed hydraulically, as follows:

(a) *Glass bottle case storage of distilled spirits*

The design and installation of in-rack sprinklers for cased glass bottle storage, shall be in accordance with the requirements of 905.12.2 for Category 3 commodities.

(b) *PET bottle case storage of distilled spirits*

The design and installation of in-rack sprinklers for cased PET bottle storage, shall be in accordance with the requirements of 905.12.2 for Category 4 commodities.

(c) *Barrel storage of distilled spirits*

In-rack sprinklers shall be installed in single-row or double-row racks when storage is more than 12 barrels (9.0 m) high, or in multiple-row racks when storage is more than six barrels (4.6 m) high.

(i) *Single-row or double-row racks*

In-rack sprinklers shall be designed and installed in accordance with the requirements of one of three alternative methods described below and as shown in figures 9.33(a) to 9.33(d), as appropriate.

Method A: In-rack sprinklers shall be installed beneath each walkway at 12-barrel or 9.1 m maximum vertical intervals. In-rack sprinklers shall be spaced horizontally not more than 3 m apart along walkways in double-row racks, and not more than 3.7 m apart along walkways in single-row racks. In-rack sprinklers shall be staggered vertically and horizontally, (see figures 9.33(a) and (b)).

Method B: In-rack sprinklers shall be installed beneath each alternate walkway at 6-barrel or 4.9 m maximum vertical intervals, spaced not more than 3 m apart along walkways in single-row and double-row racks. In-rack sprinklers shall be staggered vertically and horizontally, (see figure 9.33(c)).

Method C: For single-row and double-row rack storage not exceeding 18 barrels (14.0 m) in height, roof/ceiling sprinklers shall be supplemented by a system of 10 mm nominal orifice, spray type, 74 °C, standard spray sprinklers installed upright beneath the first tier of barrels.

Clearance between barrel bilges and sprinkler deflectors shall be 350 mm to 460 mm. Area coverage per sprinkler shall be restricted to approximately 6.5 m^2, (see figure 9.33(d))

(ii) *Multiple-row racks*

In-rack sprinklers shall be installed at six-barrel or 4.6 m maximum vertical intervals. Range pipes shall run across each row of barrels not more than 3 m apart horizontally. In-rack sprinklers shall be staggered and located in spaces between barrel heads in alternate rows of barrels, (see figure 9.33(e))

(iii) *In-rack sprinkler hydraulic design – Barrel storage*

In-rack sprinkler pipework shall be hydraulically designed to provide at least 114 L/min from each of the following number of sprinklers operating simultaneously at the hydraulically most unfavourable location within each design area:

6 sprinklers when only one level installed.

10 sprinklers (5 on each of two adjacent levels) when more than one level is installed.

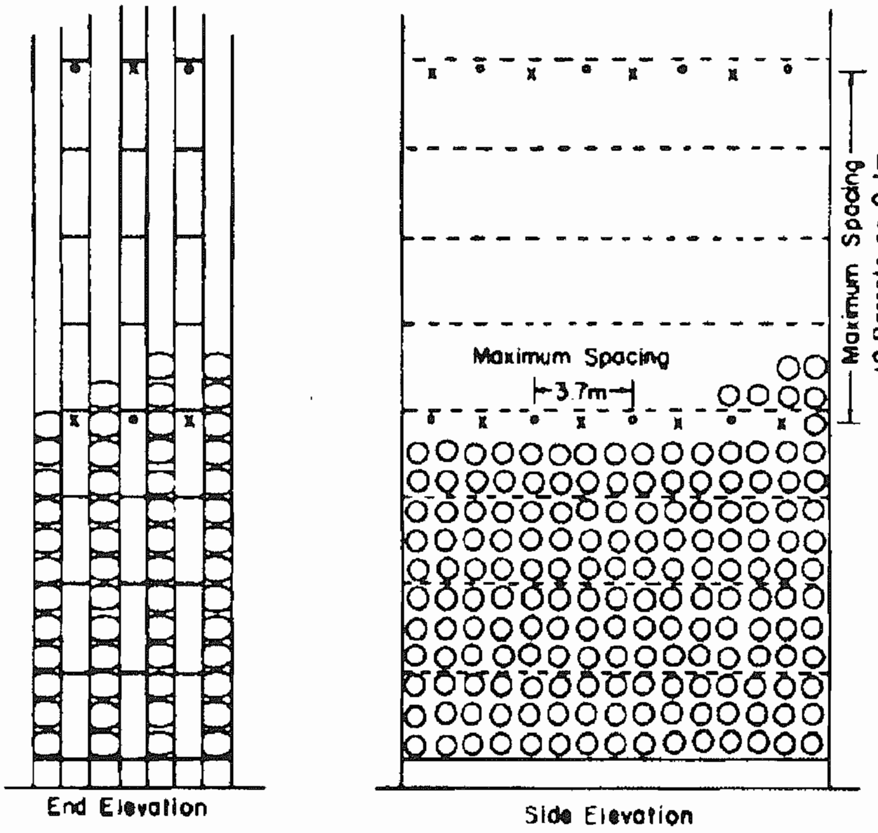


Figure 9.33(a) – Single row racks – Location of in-rack sprinklers, method A

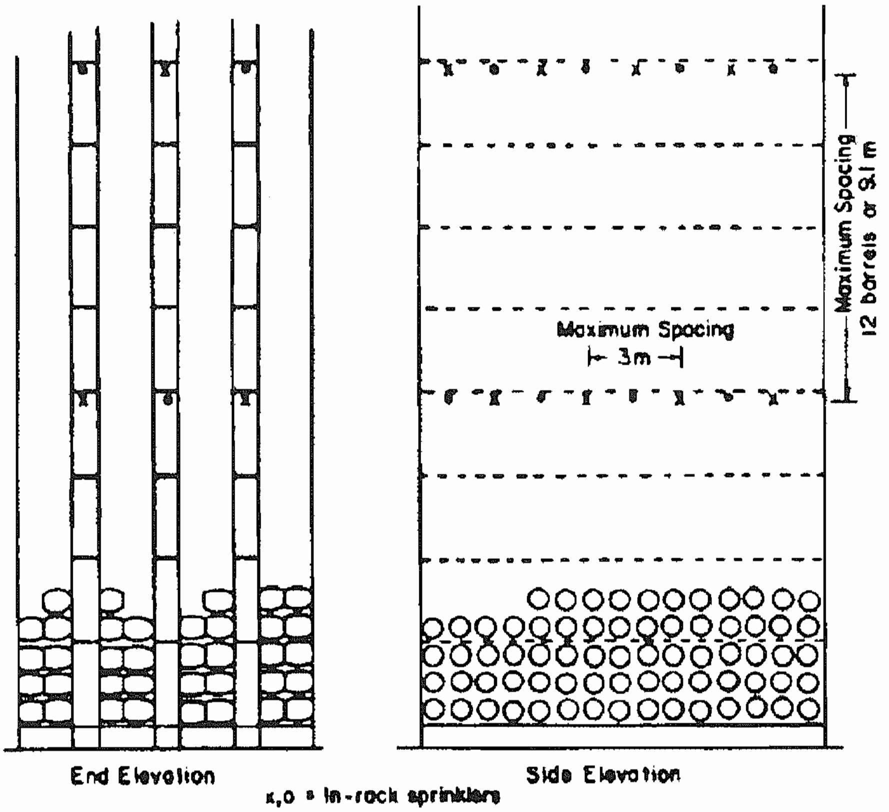


Figure 9.33(b) – Double row racks – Location of in-rack sprinklers, method A

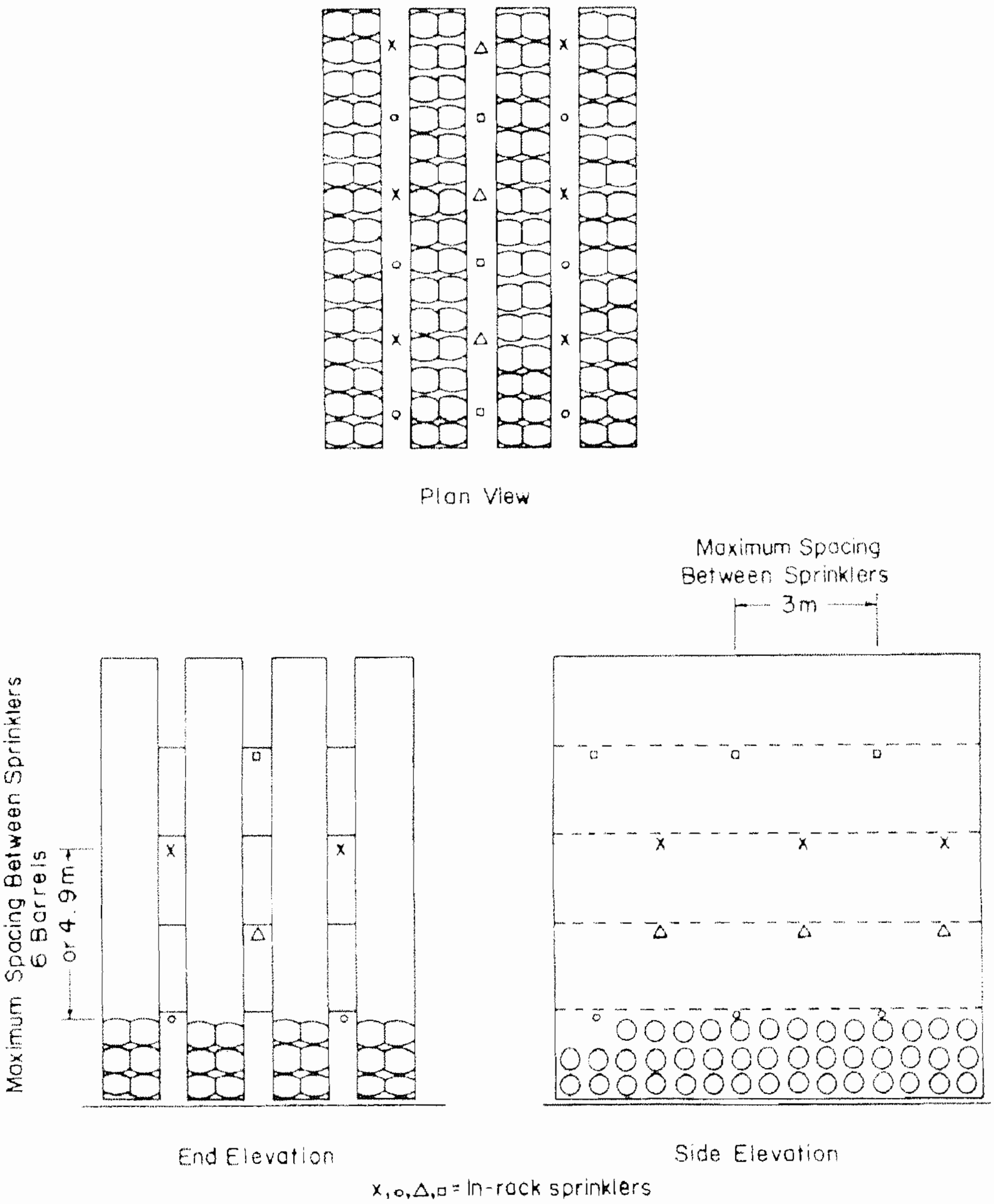
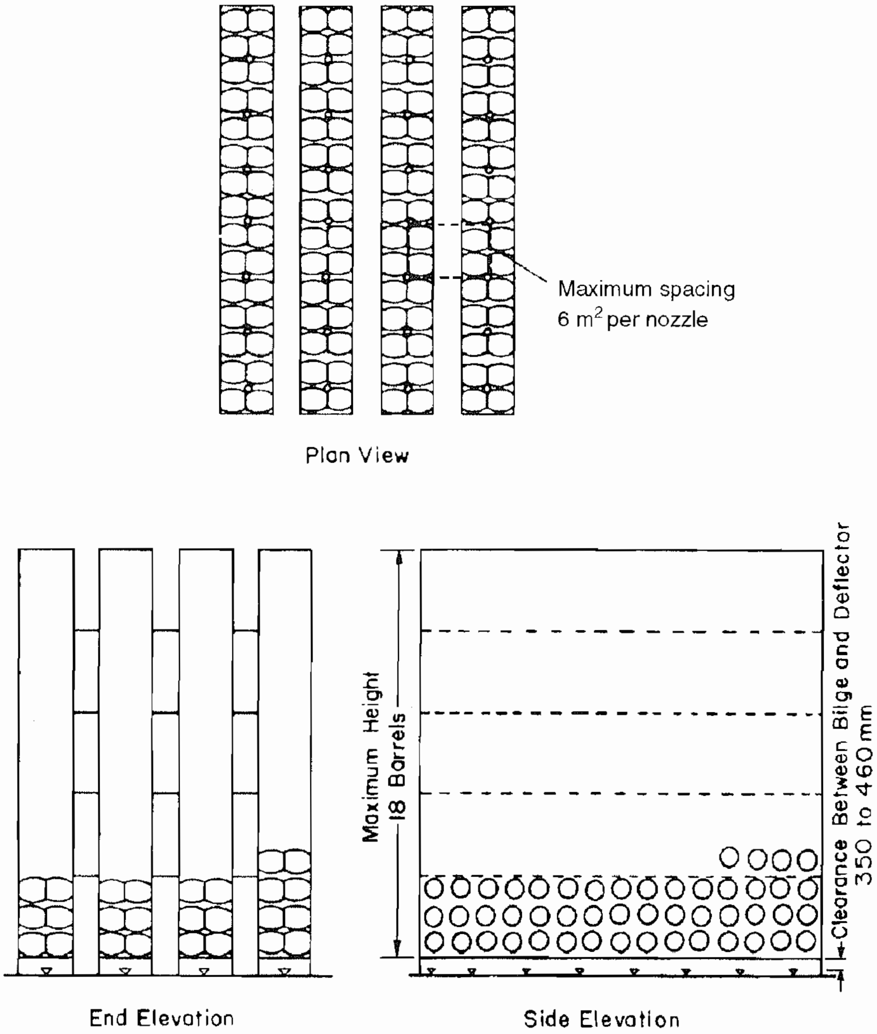

Plan View
Maximum Spacing Between Sprinklers
3m
Maximum Spacing Between Sprinklers
6 Barrels or 4.9m
End Elevation
Side Elevation
x,o,Δ,□ = In-rack sprinklers

Figure 9.33(c) – Double row racks – Location of in-rack sprinklers, method B (can also be applied to single row racks)



o,∇ = In-rack wide-angle spray nozzles or pendant sprinklers (10 mm) installed upright

Figure 9.33(d) – Double row racks – Location of in-rack sprinklers, method C (can also be applied to single row racks)

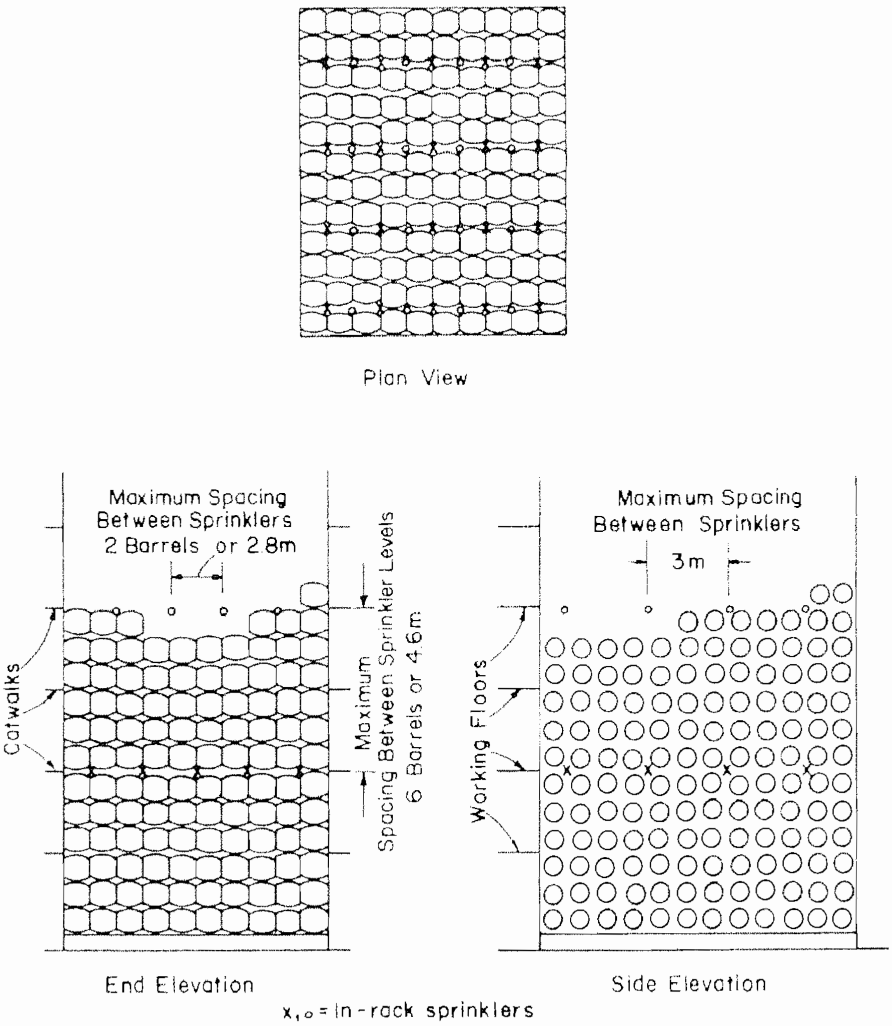

Plan View
Maximum Spacing Between Sprinklers 2 Barrels or 2.8m
Catwalks
Maximum Spacing Between Sprinkler Levels 6 Barrels or 4.6m
End Elevation
Maximum Spacing Between Sprinklers
3m
Working Floors
Side Elevation
x, o = in-rack sprinklers

Figure 9.33(e) – Multiple row racks – Location of in-rack sprinklers

908 CONTROL MODE SPECIFIC APPLICATION SPRINKLERS

NOTE – In previous editions of this Standard, control mode specific application sprinklers were known as "large drop sprinklers".

The protection options using control mode specific application sprinklers are provided in tables 9.26(a) through to 9.26(t) as follows:

(a) Tables 9.26(a) through to 9.26(o) are dedicated to rack storage. These tables do not require/allow any interpolation and/or adjustments to the indicated values except for roof slopes exceeding 10°;

(b) Tables 9.26(p) through to 9.26(s) are dedicated to solid-piled, palletised, shelf and bin-box storage arrangements. These tables do not require allow any interpolation and/or adjustments to the indicated values except for roof slopes exceeding 10°;

(c) The design requirements for protection of Category 5 and Category 6 Plastics using control mode specific application Sprinklers are dependent on whether they are cartoned, or uncartoned, and expanded, or unexpanded, and do not differ between Category 5 or Category 6 commodities.

Where roof slope exceeds 10°, increase the design number of sprinklers operating by 30 % i.e. 15 becomes 20.

If in-rack sprinklers are needed, see 904.2 and table 9.26(t) for their design criteria except maximum linear spacing is to be 3.0 m and maximum area is to be 4.5 m^2.

The control mode specific application protection tables for solid-piled, palletised, shelf and bin-box storage arrangements provide ceiling-level sprinkler protection options for storage heights up to 9.1 m in buildings up to 15.2 m high. In addition, the control mode specific application protection tables for all rack storage arrangements provide ceiling level sprinkler protection options for storage heights up to 7.6 m in buildings up to 13.7 m high.

NOTE – Where CMSA sprinklers have glass bulbs then temperatures of 68 °C and 141 °C are accepted as equivalent to 70 °C and 140 °C respectively in the tables.

Control mode specific application sprinklers having a *K* factor of 24 are presently limited to wet systems only (pre-action systems are not presently permitted with this *K* factor value either).

Table 9.26(a) – Control mode specific application sprinklers for rack storage of category 1 and 2 commodities with open shelves

Maximum storage height (m)	**Maximum building height** (m)	**Category 1, Category 2 commodities, with none/open/less than 2.0 m^2 shelves**			
		Wet pipe – No. A.S. pressure (kPa)		**Dry pipe – No. A.S. pressure** (kPa)	
		***K* factor 24 70 °C**	***K* factor 16 70 °C**	***K* factor 24 140 °C**	***K* factor 16 140 °C**
6.1	9.1	15 @ 70	15 @ 170	DNA	25 @ 170
	12.2	DNA	15 @ 170	DNA	25 @ 170
	13.7	DNA	20@ 170	DNA	30 @ 170
7.6	9.1	15 @ 70	20 @ 170	DNA	30 @ 170
	13.7	DNA	20 @ 170	DNA	30 @ 170
9.1	10.7	DNA	20 @ 170 & 1 level IRS	DNA	30 @ 170 & 1 level IRS
	10.7	DNA	36 @ 380 (Note 1)	DNA	DNA
	12.2	DNA	36 @ 380 (Note 1)	DNA	DNA
10.7	12.2	DNA	36 @ 380 (Note 1)	DNA	DNA

NOTE –

(1) This design is based on the most remote six sprinklers on the most remote six branch lines.

(2) Where roof slope exceeds 10°, increase the design number of sprinklers operating by 30 %.

Table 9.26(b) – Control mode specific application sprinklers for rack storage of category 1 and 2 commodities with solid shelves 2.0 to 6.0 m^2

Maximum storage height (m)	**Maximum building height** (m)	**Category 1 and 2 commodities, with solid shelves 2.0 to 6.0 m^2**			
		Wet pipe – No. A.S. pressure (kPa)		**Dry pipe – No. A.S. pressure** (kPa)	
		***K* factor 24** **70 °C**	***K* factor 16** **70 °C**	***K* factor 24** **140 °C**	***K* factor 16** **140 °C**
4.6	10.7	DNA	15 @ 170	DNA	25 @ 170
	12.2	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
	13.7	DNA	15 @ 170 & 2 Levels IRS	DNA	25 @ 170 & 2 Levels IRS
6.1	12.2	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
	13.7	DNA	15 @ 170 & 2 Levels IRS	DNA	25 @ 170 & 2 Levels IRS
7.6	13.7	DNA	15 @ 170 & 2 Levels IRS	DNA	25 @ 170 & 2 Levels IRS

NOTE – Where roof slope exceeds 10°, increase the design number of sprinklers operating by 30 %.

Table 9.26(c) – Control mode specific application sprinklers for rack storage of category 1 and 2 commodities with solid shelves greater than 6.0 m^2

Maximum storage height (m)	**Maximum building height** (m)	**Category 1 and 2 commodities, with solid shelves greater than 6.0 m^2**			
		Wet pipe, No. A.S. pressure (kPa)		**Dry pipe – No. A.S. pressure** (kPa)	
		***K* factor 24** **70 °C**	***K* factor 16** **70 °C**	***K* factor 24** **140 °C**	***K* factor 16** **140 °C**
3.0	13.7	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
7.6	13.7	DNA	15 @ 170 & 1 Level IRS at every tier	DNA	25 @ 170 & 1 Level IRS at every tier

NOTE – Where roof slope exceeds 10°, increase the design number of sprinklers operating by 30%.

Table 9.26(d) – Control mode specific application sprinklers for rack storage of category 3 commodities with open shelves

Maximum storage height (m)	Maximum building height (m)	Category 3 commodities with none/open/less than 2.0 m^2 shelves			
		Wet pipe – No. A.S. pressure (kPa)		Dry pipe – No. A.S. pressure (kPa)	
		K factor 24 70 °C	*K* factor 16 70 °C	*K* factor 24 140 °C	*K* factor 16 140 °C
6.1	9.1	15 @ 150	15 @ 170	DNA	25 @ 170
	12.2	DNA	15 @ 170	DNA	25 @ 170
	13.7	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
7.6	9.1	15 @ 150	18 @ 350	DNA	25 @ 170 & 1 Level IRS
	12.2	DNA	20 @ 350	DNA	25 @ 170 & 1 Level IRS
	13.7	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
NOTE – Where roof slope exceeds 10°, increase the design number of sprinklers operating by 30 %.					

Table 9.26(e) – Control mode specific application sprinklers for rack storage of category 3 commodities with solid shelves 2.0 to 6.0 m^2

Maximum storage height (m)	Maximum building height (m)	Category 3 commodities, with solid shelves 2.0 to 6.0 m^2			
		Wet pipe – No. A.S. pressure (kPa)		Dry pipe – No. A.S. pressure (kPa)	
		K factor 24 70 °C	*K* factor 16 70 °C	*K* factor 24 140 °C	*K* factor 16 140 °C
4.6	10.7	DNA	15 @ 170	DNA	25 @ 170
	12.2	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
	13.7	DNA	15 @ 170 & 2 Levels IRS	DNA	25 @ 170 & 2 Levels IRS
6.1	12.2	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
	13.7	DNA	15 @ 170 & 2 Levels IRS	DNA	25 @ 170 & 2 Levels IRS
7.6	13.7	DNA	15 @ 170 & 2 Levels IRS	DNA	25 @ 170 & 2 Levels IRS
NOTE – Where roof slope exceeds 10°, increase the design number of sprinklers operating by 30 %.					

Table 9.26(f) – Control mode specific application sprinklers for rack storage of category 3 commodities with solid shelves greater than 6.0 m^2

Maximum storage height (m)	Maximum building height (m)	Category 3 commodities, with solid shelves greater than 6.0 m^2			
		Wet pipe – No. A.S. pressure (kPa)		Dry pipe – No. A.S. pressure (kPa)	
		K factor 24 70 °C	*K* factor 16 70 °C	*K* factor 24 140 °C	*K* factor 16 140 °C
3.0	13.7	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
7.6	13.7	DNA	15 @ 170 & 1 Level IRS at every tier	DNA	25 @ 170 & 1 Level IRS at every tier

NOTE – Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(g) – Control mode specific application sprinklers for rack storage of category 4 commodities with open shelves

Maximum storage height (m)	Maximum building height (m)	Category 4 commodities, with none/open/less than 2.0 m^2 shelves			
		Wet pipe – No. A.S. pressure (kPa)		Dry pipe – No. A.S. pressure (kPa)	
		K factor 24 70 °C	*K* factor 16 70 °C	*K* factor 24 140 °C	*K* factor 16 140 °C
4.6	6.1	25 @ 150	36 @ 350	25 @ 150 & 1 Level IRS	25 @ 350 & 1 Level IRS
	9.1	25 @ 150	36 @ 350	25 @ 150 & 1 Level IRS	25 @ 350 & 1 Level IRS
	13.7	DNA	20 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
6.1	7.6	25 @ 150	36 @ 350	DNA	25 @ 350 & 1 Level IRS
			15 @ 170 & 1 Level IRS	25 @ 150 & 1 Level IRS	
	9.1	25 @ 150	36 @ 350	DNA	25 @ 350 & 1 Level IRS
			15 @ 350 & 1 Level IRS	25 @ 150 & 1 Level IRS	
	12.2	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
	13.7	DNA	20 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
7.6	9.1	25 @ 150	36 @ 350	DNA	25 @ 350 & 1 Level IRS
			15 @ 350 & 1 Level IRS		
	13.7	DNA	20 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS

NOTE – Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(h) – Control mode specific application sprinklers for rack storage of category 4 commodities with solid shelves 2.0 to 6.0 m^2

Maximum storage height (m)	**Maximum building height** (m)	**Category 4 commodities, with solid shelves 2.0 to 6.0 m^2**			
		Wet pipe – No. A.S. pressure (kPa)		**Dry Pipe – No. A.S. pressure** (kPa)	
		***K* factor 24** **70 °C**	***K* factor 16** **70 °C**	***K* factor 24** **140 °C**	***K* factor 16** **140 °C**
3.0	9.1	DNA	15 @ 350 & 1 Level IRS	25 @ 150 & 1 Level IRS	25 @ 170 & 1 Level IRS
	13.7	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
4.6	12.2	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
	13.7	DNA	15 @ 350 & 2 Levels IRS	DNA	25 @ 350 & 2 Levels IRS
6.1	7.6	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
	12.2	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
	13.7	DNA	15 @ 350 & 2 Levels IRS	DNA	25 @ 350 & 2 Levels IRS
7.6	9.1	DNA	15 @ 350 & 2 Levels IRS	DNA	25 @ 350 & 2 Levels IRS
	13.7	DNA	15 @ 350 & 2 Levels IRS	DNA	25 @ 350 & 2 Levels IRS
NOTE – Where roof slope exceeds 10°, increase the design number operating by 30 %.					

Table 9.26(i) – Control mode specific application sprinklers for rack storage of category 4 commodities with solid shelves greater than 6.0 m^2

Maximum storage height (m)	**Maximum building height** (m)	**Category 4 commodities, with solid shelves greater than 6.0 m^2**			
		Wet pipe – No. A.S. pressure (kPa)		**Dry pipe – No. A.S. pressure** (kPa)	
		***K* factor 24** **70 °C**	***K* factor 16** **70 °C**	***K* factor 24** **140 °C**	***K* factor 16** **140 °C**
3.0	9.1	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
	13.7	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
6.1	13.7	DNA	15 @ 350 & 1 Level IRS at every tier	DNA	25 @ 350 & 1 Level IRS at every tier
7.6	13.7	DNA	15 @ 170 & 1 Level IRS at every tier	DNA	25 @ 170 & 1 Level IRS at every tier
NOTE – Where roof slope exceeds 10°, increase the design number operating by 30 %.					

Table 9.26(j) – Control mode specific application sprinklers for rack storage of cartoned expanded plastic and cartoned unexpanded plastic with open shelves

Maximum storage height (m)	**Maximum building height** (m)	**Cartoned expanded plastic, cartoned unexpanded plastic and uncartoned unexpanded plastic, with none/open/less than 2.0 m^2 shelves**			
		Wet pipe – No. A.S. Pressure (kPa)		**Dry pipe – No. A.S. pressure** (kPa)	
		***K* factor 24 70 °C**	***K* factor 16 70 °C**	***K* factor 24 140 °C**	***K* factor 16 140 °C**
4.6	6.1	25 @ 150	36 @ 350	25 @ 150 & 1 Level IRS	25 @ 350 & 1 Level IRS
	9.1	25 @ 150	36 @ 350	25 @ 150 & 1 Level IRS	25 @ 350 & 1 Level IRS
	10.7	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
	12.2	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
	13.7	DNA	30 @ 350 & 1 Level IRS	DNA	25 @ 170 & 2 Levels IRS
6.1	7.6	25 @ 150	36 @ 350	25 @ 150 & 1 Level IRS	25 @ 350 & 1 Level IRS
	9.1	25 @ 150	36 @ 350	25 @ 150 & 1 Level IRS	25 @ 350 & 1 Level IRS
	12.2	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
	13.7	DNA	30 @ 350 & 1 Level IRS	DNA	25 @ 170 & 2 Levels IRS
			15 @ 350 & 2 Levels IRS		
7.6	9.1	25 @ 150	36 @ 350	25 @ 150 & 1 Level IRS	25 @ 350 & 1 Level IRS
	13.7	DNA	30 @ 350 & 1 Level IRS	DNA	25 @ 170 & 2 Levels IRS
			15 @ 350 & 2 Levels IRS		

NOTE – Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(k) – Control mode specific application sprinklers for rack storage of cartoned expanded plastic, cartoned unexpanded plastic and uncartoned unexpanded plastic with solid shelves 2.0 to 6.0 m^2

Maximum storage height (m)	**Maximum building height** (m)	**Cartoned expanded plastic, cartoned unexpanded plastic and uncartoned unexpanded plastic, with solid shelves 2.0 to 6.0 m^2**			
		Wet pipe – No. A.S. pressure (kPa)		**Dry pipe – No. A.S. pressure** (kPa)	
		***K* factor 24 70 °C**	***K* factor 16 70 °C**	***K* factor 24 70 °C**	***K* factor 16 140 °C**
3.0	9.1	DNA	15 @ 350 & 1 Level IRS	25 @ 150 1 level IRS	25 @ 350 & 1 Level IRS
	13.7	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
4.6	12.2	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
	13.7	DNA	15 @ 350 & 2 Levels IRS	DNA	25 @ 350 & 2 Levels IRS
6.1	12.2	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
	13.7	DNA	15 @ 350 & 2 Levels IRS	DNA	25 @ 350 & 2 Levels IRS
7.6	13.7	DNA	15 @ 350 & 2 Levels IRS	DNA	25 @ 350 & 2 Levels IRS
NOTE – Where roof slope exceeds 10°, increase the design number operating by 30 %.					

Table 9.26(I) – Control mode specific application sprinklers for rack storage of cartoned expanded plastic, cartoned unexpanded plastic and uncartoned unexpanded plastic with solid shelves greater than 6.0 m^2

Maximum storage height (m)	Maximum building height (m)	Cartoned expanded plastic, cartoned unexpanded plastic and uncartoned unexpanded plastic, with solid shelves greater than 6.0 m^2			
		Wet pipe – No. A.S. pressure (kPa)		Dry pipe – No. A.S. pressure (kPa)	
		K factor 24 70 °C	*K* factor 16 70 °C	*K* factor 24 140 °C	*K* factor 16 140 °C
3.0	9.1	DNA	15 @ 170 & 1 Level IRS	DNA	25 @ 170 & 1 Level IRS
	13.7	DNA	15 @ 350 & 1 Level IRS	DNA	25 @ 350 & 1 Level IRS
4.6	10.7	DNA	15 @ 170 & 1 Level IRS at every tier	DNA	25 @ 170 & 1 Level IRS at every tier
	13.7	DNA	15 @ 350 & 1 Level IRS at every tier	DNA	25 @ 350 & 1 Level IRS at every tier
6.1	12.2	DNA	15 @ 170 & 1 Level IRS at every tier	DNA	25 @ 170 & 1 Level IRS at every tier
	13.7	DNA	15 @ 350 & 1 Level IRS at every tier	DNA	25 @ 350 & 1 Level IRS at every tier
7.6	13.7	DNA	15 @ 350 & 1 Level IRS at every tier	DNA	25 @ 170 & 1 Level IRS at every tier
NOTE – Where roof slope exceeds 10°, increase the design number operating by 30 %.					

Table 9.26(m) – Control mode specific application sprinklers for rack storage of uncartoned expanded plastic and uncartoned unexpanded plastic with open shelves

Maximum storage height (m)	Maximum building height (m)	Uncartoned expanded and uncartoned unexpanded plastic with none/open/less than 2.0 m^2 shelves			
		Wet pipe – No. A.S. pressure (kPa)		Dry pipe – No. A.S. pressure (kPa)	
		K factor 24 70 °C	*K* factor 16 70 °C	*K* factor 24 140 °C	*K* factor 16 140 °C
3.0	7.6	25 @ 150	25 @ 350	36 @ 150	36 @ 350
	10.7	DNA	20 @ 170 & 1 Level IRS	DNA	30 @ 170 & 1 Level IRS
	12.2	DNA	20 @ 350 & 1 Level IRS	DNA	30 @ 350 & 1 Level IRS
	13.7	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
4.6	10.7	DNA	20 @ 170 & 1 Level IRS	DNA	30 @ 170 & 1 Level IRS
	12.2	DNA	20 @ 350 & 1 Level IRS	DNA	30 @ 350 & 1 Level IRS
	13.7	DNA	20 @ 350 & 2 Levels IRS	DNA	30 @ 350 & 2 Levels IRS
6.1	12.2	DNA	20 @ 350 & 1 Level IRS	DNA	30 @ 350 & 1 Level IRS
	13.7	DNA	20 @ 350 & 2 Levels IRS	DNA	30 @ 350 & 2 Levels IRS
7.6	13.7	DNA	20 @ 350 & 2 Levels IRS	DNA	30 @ 350 & 2 Levels IRS

NOTE –

(1) See 910 for details concerning Fire Protection Scheme A.

(2) Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(n) – Control mode specific application sprinklers for rack storage of uncartoned expanded plastic with solid shelves 2.0 to 6.0 m^2

Maximum storage height (m)	**Maximum building height** (m)	**Uncartoned expanded plastic with solid shelves 2.0 to 6.0 m^2**			
		Wet pipe – No. A.S. pressure (kPa)		**Dry pipe – No. A.S. pressure** (kPa)	
		***K* factor 24 70 °C**	***K* factor 16 70 °C**	***K* factor 24 140 °C**	***K* factor 16 140 °C**
3.0	9.1	DNA	25 @ 170 & 1 Level IRS	DNA	30 @ 170 & 1 Level IRS
	10.7	DNA	25 @ 170 & 1 Level IRS	DNA	30 @ 170 & 1 Level IRS
	12.2	DNA	20 @ 350 & 1 Level IRS	DNA	30 @ 350 & 1 Level IRS
	13.7	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
4.6	10.7	DNA	25 @ 170 & 1 Level IRS	DNA	30 @ 170 & 1 Level IRS
	12.2	DNA	20 @ 350 & 1 Level IRS	DNA	30 @ 350 & 1 Level IRS
	13.7	DNA	20 @ 350 & 2 Levels IRS	DNA	30 @ 350 & 2 Levels IRS
6.1	12.2	DNA	20 @ 350 & 1 Level IRS	DNA	30 @ 350 & 1 Level IRS
	13.7	DNA	20 @ 350 & 2 Levels IRS	DNA	30 @ 350 & 2 Levels IRS
7.6	13.7	DNA	20 @ 350 & 2 Levels IRS	DNA	30 @ 350 & 2 Levels IRS

NOTE –

(1) See 910 for details concerning Fire Protection Scheme A.

(2) Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(o) – Control mode specific application sprinklers for rack storage of uncartoned expanded plastic with solid shelves greater than 6.0 m^2

Maximum storage height (m)	Maximum building height (m)	Uncartoned expanded plastic with solid shelves greater than 6.0 m^2			
		Wet pipe – No. A.S. pressure (kPa)		**Dry pipe, No. A.S. pressure (kPa)**	
		***K* factor 24 70 °C**	***K* factor 16 70 °C**	***K* factor 24 140 °C**	***K* factor 16 140 °C**
3.0	9.1	DNA	20 @ 170 & 1 Level IRS	DNA	30 @ 170 & 1 Level IRS
	10.7	DNA	20@ 350 & 1 Level IRS	DNA	30 @ 350 & 1 Level IRS
	13.7	DNA	Scheme A Note 1	DNA	Scheme A Note 1
4.6	10.7	DNA	25 @ 170 & 1 Level IRS at every tier	DNA	30 @ 170 & 1 Level IRS at every tier
	12.2	DNA	20 @ 350 & 1 Level IRS at every tier	DNA	30 @ 350 & 1 Level IRS at every tier
	13.7	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
6.1	12.2	DNA	20 @ 170 & 1 Level IRS at every tier	DNA	30 @ 170 & 1 Level IRS at every tier
	13.7	DNA	20 @ 350 & 1 Level IRS at every tier	DNA	30 @ 350 & 1 Level IRS at every tier
7.6	13.7	DNA	20 @ 170 & 1 Level IRS at every tier	DNA	30 @ 170 & 1 Level IRS at every tier

NOTE –

(1) See 910 for details concerning Fire Protection Scheme A.

(2) Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(p) – Control mode specific application sprinklers for solid-piled, palletised, shelf and bin-box storage of category 1, 2, 3, and 4 commodities

Commodity	**Maximum storage height** (m)	**Maximum building height** (m)	**Wet pipe – No. A.S. pressure** (kPa)		**Dry pipe – No. A.S. pressure** (kPa)	
			***K* factor 24 70 °C**	***K* factor 16 70 °C**	***K* factor 24 140 °C**	***K* factor 16 140 °C**
Category 1 and 2	7.6	9.1	15 @ 70	15 @ 170	DNA	25 @ 170
		12.2	DNA	15 @ 170	DNA	25 @ 170
		15.2	DNA	36 @ 380 (Note 1)	DNA	DNA
	9.1	15.2	DNA	15 @ 170	DNA	25 @ 170
	10.7	12.2	DNA	36 @ 380 (Note 1)	DNA	DNA
Category 3	7.6	9.1	15 @ 150	15 @ 170	DNA	25 @ 170
	9.1	15.2	DNA	15 @ 170	DNA	25 @ 170
Category 4	4.6	9.1	15 @ 150	15 @ 170	DNA	25 @ 170
		10.7	DNA	15 @ 170	DNA	25 @ 170
		13.7	DNA	20 @ 170 15 @ 350	DNA	25 @ 170
		15.2	DNA	20 @ 350	DNA	25 @ 350
	6.1	9.1	15 @ 150	20 @ 170	DNA	25 @ 170
		13.7	DNA	20 @ 170 15 @ 350	DNA	25 @ 170
		15.2	DNA	20 @ 350	DNA	25 @ 350
	7.6	9.1	15 @ 150	20 @ 170	DNA	25 @ 170
		13.7	DNA	20 @ 170 15 @ 350	DNA	25 @ 170
		15.2	DNA	20 @ 350	DNA	25 @ 350
	9.1	15.2	DNA	20 @ 350	DNA	25 @ 350

NOTE –

(1) This design is based on the most remote six sprinklers on the most remote six branch lines.

(2) Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(q) – Control mode specific application sprinklers for shelf and bin-box storage of cartoned and uncartoned unexpanded plastic and cartoned expanded plastic

Maximum storage height (m)	**Maximum building height** (m)	**Cartoned and uncartoned unexpanded plastic and cartoned expanded plastic**			
		Wet pipe – No. A.S. pressure (kPa)		**Dry pipe – No. A.S. pressure** (kPa)	
		***K* factor 24 70 °C**	***K* factor 16 70 °C**	***K* factor 24 140 °C**	***K* factor 16 140 °C**
4.6	9.1	15 @ 150 Note 2	15 @ 170	DNA	25 @ 170
	10.7	DNA	15 @ 170	DNA	25 @ 170
	12.2	DNA	25 @ 170 15 @ 350	DNA	25 @ 350
	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
6.1	7.6	15 @ 150 Note 2	15 @ 170	DNA	25 @ 170
	9.1	15 @ 150 Note 2	25 @ 170	DNA	25 @ 350
	12.2	DNA	25 @ 170 15 @ 350	DNA	25 @ 350
	15.2	DNA	Scheme A Note 1	DNA	Scheme A Note 1
7.6	9.1	15 @ 150 Note 2	18 @ 350	DNA	30 @ 350
	15.2	DNA	Scheme A Note 1	DNA	Scheme A Note 1
9.1	15.2	DNA	Scheme A Note 1	DNA	Scheme A Note 1

NOTE –

(1) See 910 for details concerning Fire Protection Scheme A.

(2) This design only applies to cartoned and uncartoned unexpanded plastic commodities.

(3) Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(r) – Control mode specific application sprinklers for solid-piled and palletised storage of cartoned and uncartoned unexpanded plastic and cartoned expanded plastic

Maximum storage height (m)	Maximum building height (m)	Cartoned and uncartoned unexpanded plastic and cartoned expanded plastic			
		Wet pipe – No. A.S. pressure (kPa)		Dry pipe – No. A.S. pressure (kPa)	
		K factor 24 70 °C	*K* factor 16 70 °C	*K* factor 24 140 °C	*K* factor 16 140 °C
3.0	9.1	15 @ 150 Note 2	15 @ 170	DNA	25 @ 170
	10.7	DNA	25 @ 170 15 @ 350	DNA	30 @ 170
	12.2	DNA	25 @ 170 15 @ 350	DNA	Scheme A (Note 1)
	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
4.6	9.1	15 @ 150 (Note 2)	25 @ 170	DNA	30 @ 170
	10.7	DNA	25 @ 170 15 @ 350	DNA	30 @ 170
	12.2	DNA	25 @ 170 15 @ 350	DNA	Scheme A (Note 1)
	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
6.1	9.1	15 @ 150 (Note 2)	25 @ 170 15 @ 350	DNA	25 @ 350
	12.2	DNA	25 @ 170 15 @ 350	DNA	Scheme A (Note 1)
	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
7.6	9.1	15 @ 150 (Note 2)	18 @ 350	DNA	Scheme A (Note 1)
	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
9.1	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
10.7	12.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)

NOTE –

(1) See 910 for details concerning Fire Protection Scheme A.

(2) This design only applies to cartoned and uncartoned unexpanded plastic commodities.

(3) Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(s) – Control mode specific application sprinklers for solid-piled, palletised, shelf and bin-box storage of uncartoned expanded plastic

Maximum storage height (m)	Maximum building height (m)	Uncartoned expanded plastic			
		Wet pipe – No. A.S. pressure (kPa)		Dry pipe – No. A.S. pressure (kPa)	
		K factor 24 70 °C	*K* factor 16 70 °C	*K* factor 24 140 °C	*K* factor 16 140 °C
3.0	4.6	DNA	15 @ 170	DNA	25 @ 170
	9.1	DNA	15 @ 350	DNA	25 @ 350
	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
4.6	9.1	DNA	15 @ 350	DNA	25 @ 350
	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
6.1	9.1	DNA	15 @ 350	DNA	25 @ 350
	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
9.1	15.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)
10.7	12.2	DNA	Scheme A (Note 1)	DNA	Scheme A (Note 1)

NOTE –

(1) See 910 for details concerning Fire Protection Scheme A.

(2) Where roof slope exceeds 10°, increase the design number operating by 30 %.

Table 9.26(t) – Control mode specific application in-rack sprinkler design criteria

Storage Height (m)	Commodity	In-rack levels provided	Design number of IRS	IRS design minimum design flow (L/min)
≤ 7.6	Category 1, 2 or 3	1 Level	6 on 1 level	85
≤ 7.6	Category 4	1 Level	8 on 1 level	85
≤ 7.6	Category 5 or 6	1 Level	8 on 1 level	115
≤ 7.6	Category 1, 2 or 3	2 Levels, 3 Levels, 1 level at each tier	5 on 2 levels	85
≤ 7.6	Category 4	2 Levels, 3 Levels, 1 level at each tier	7 on 2 levels	85
≤ 7.6	Category 5 or 6	2 Levels, 3 Levels, 1 level at each tier	7 on 2 levels	115
> 7.6	Category 1, 2 or 3	1 Level	6 on 1 level	115
> 7.6	Category 4, 5 or 6	1 Level	8 on 1 level	115
> 7.6	Category 1, 2 or 3	2 Levels, 3 Levels, 1 level at each tier	5 on 2 levels	115
> 7.6	Category 4, 5 or 6	2 Levels, 3 Levels, 1 level at each tier	7 on 2 levels	115

909 SUPPRESSION MODE SPRINKLERS

NOTE –

(1) In previous editions of this Standard, suppression mode sprinklers were called early suppression fast response sprinklers.

(2) The head pressures nominated in this Standard for 25 mm K36 suppression mode sprinklers are based on the UL listing criteria at the date of publication of this Standard. Some other approval bodies may specify higher head pressures. One such organisation at the date of publication is FM Global. For the convenience of the users of this Standard, FM Global's minimum head pressures are listed in this Standard, for information only. The user of the Standard is advised to confirm the requirements for designing with *K*36 25 mm suppression mode sprinklers with the building owner's insurers.

The protection options utilising suppression mode sprinklers are provided in tables 9.27(a) through to 9.27(m) as follows:

(a) Tables 9.27(a) through to 9.27(d) are dedicated to rack storage. These tables do not allow any interpolation and/or adjustments to the indicated values;

(b) Tables 9.27(e) through to 9.27(h) are dedicated to solid-piled, palletised, shelf and bin-box storage arrangements. These tables do not allow any interpolation and/or adjustments to the indicated values;

(c) The design requirements for protection of Category 5 and Category 6 Plastics using suppression mode Sprinklers are dependent on whether they are cartoned, or uncartoned, and expanded, or unexpanded, and do not differ between Category 5 or Category 6 commodities.

If in-rack sprinklers are needed, see 904.2, however the maximum linear spacing is to be 1.5 m and the maximum area is to be 2.3 m^2. Allow for 8 20 mm *K*11.5 sprinklers to operate on a single level with all sprinklers discharging a minimum of 230 L/min.

If additional sprinklers are required below obstructions see 518.4 for additional hydraulic design requirements.

Table 9.27(a) – Suppression mode sprinklers for rack storage of Category 1, 2, 3 and 4 commodities and cartoned, unexpanded plastics with open shelves

Maximum storage height (m)	Maximum building height (m)	Category 1, Category 2, Category 3, Category 4 and cartoned unexpanded plastics						
		Wet Pipe, No. A.S. pressure (kPa)						
		_K_ factor 36, 70 °C Pendent (ANSI/ NFPA Design criteria) (see note)	**_K_ factor 36, 70 °C Pendent (FM Design criteria)**	**_K_ factor 32, 70 °C Pendent**	**_K_ factor 24, 70 °C Pendent**	**_K_ factor 24, 70 °C Upright**	**_K_ factor 20, 70 °C Pendent**	**_K_ factor 20, 70 °C Upright**
7.6	9.1	12 @ 100	12 @ 140	12 @ 170	12 @ 240	12 @ 240	12 @ 350	12 @ 350
	9.7	12 @ 140	12 @ 170	12 @ 210	12 @ 290	12 @ 290	12 @ 410	12 @ 410
	10.7	12 @ 140	12 @ 210	12 @ 240	12 @ 360	12 @ 360	12 @ 520	12 @ 520
	12.2	12 @ 170	12 @ 270	12 @ 310	12 @ 360	DNA	12 @ 520	DNA
	13.7	12 @ 280	12 @ 350	12 @ 350	12 @ 430 & 1 Level IRS	DNA	12 @ 620 & 1 Level IRS	DNA
9.1	10.7	12 @ 140	12 @ 210	12 @ 240	12 @ 360	12 @ 360	12 @ 520	12 @ 520
	12.2	12 @ 170	12 @ 270	12 @ 310	12 @ 360	DNA	12 @ 520	DNA
	13.7	12 @ 280	12 @ 350	12 @ 350	12 @ 430 & 1 Level IRS	DNA	12 @ 620 & 1 Level IRS	DNA
10.7	12.2	12 @ 170	12 @ 270	12 @ 310	12 @ 360	DNA	12 @ 520	DNA
	13.7	12 @ 280	12 @ 350	12 @ 350	12 @ 430 & 1 Level IRS	DNA	12 @ 620 & 1 Level IRS	DNA
12.2	13.7	12 @ 280	12 @ 350	12 @ 350	12 @ 430 & 1 Level IRS	DNA	12 @ 620 & 1 Level IRS	DNA

NOTE – The design criteria for the sprinklers in this column are not endorsed by FM Global, which developed the data in the rest of this table. The designer is free to make the decision on which column to use for _K_36 sprinklers, subject to listing and design brief.

Table 9.27(b) – Suppression mode sprinklers for rack storage of uncartoned unexpanded plastics with open shelves

Maximum storage height (m)	**Maximum building height** (m)	**Uncartoned unexpanded plastics**					
		Wet pipe, No. A.S. pressure (kPa)					
		***K* factor 36, 70 °C pendent**	***K* factor 32, 70 °C pendent**	***K* factor 24, 70 °C pendent**	***K* factor 24, 70 °C upright**	***K* factor 20, 70 °C pendent**	***K* factor 20, 70 °C upright**
7.6	9.1	12 @ 240	12 @ 240	12 @ 240	Scheme A (Note)	12 @ 350	Scheme A (Note)
	9.7	12 @ 290	12 @ 290	12 @ 290	Scheme A (Note)	12 @ 410	Scheme A (Note)
	10.7	12 @ 350	12 @ 350	12 @ 360	Scheme A (Note)	12 @ 520	Scheme A (Note)
	12.2	12 @ 350	12 @ 350	12 @ 360	DNA	12 @ 520	DNA
	13.7	12 @ 350 1 Level IRS	12 @ 350 1 Level IRS	12 @ 430 1 Level IRS	DNA	12 @ 620 & 1 Level IRS	DNA
9.1	10.7	12 @ 350	12 @ 350	Scheme A (Note)	Scheme A (Note)	12 @ 520	Scheme A (Note)
	12.2	12 @ 350	12 @ 350	12 @ 360	DNA	12 @ 520	DNA
	13.7	12 @ 350 1 Level IRS	12 @ 350 1 Level IRS	12 @ 430 & 1 Level IRS	DNA	12 @ 620 & 1 Level IRS	DNA
10.7	12.2	12 @ 350	12 @ 350	12 @ 360	DNA	12 @ 520	DNA
	13.7	12 @ 350 1 Level IRS	12 @ 350 1 Level IRS	12 @ 430 & 1 Level IRS	DNA	12 @ 620 & 1 Level IRS	DNA
12.2	13.7	12 @ 350 1 Level IRS	12 @ 350 1 Level IRS	12 @ 430 & 1 Level IRS	DNA	12 @ 620 & 1 Level IRS	DNA

NOTE – See 910 for details concerning Fire Protection Scheme A.

Table 9.27(c) – Suppression mode sprinklers for rack storage of cartoned expanded plastics with open shelves

Maximum storage height (m)	**Maximum building height** (m)	**Cartoned expanded plastics**					
		Wet pipe, No. A.S. pressure (kPa)					
		***K* factor 36, 70 °C pendent**	***K* factor 32, 70 °C pendent**	***K* factor 24, 70 °C pendent**	***K* factor 24, 70 °C upright**	***K* factor 20, 70 °C pendent**	***K* factor 20, 70 °C upright**
7.6	9.1	12 @ 240	12 @ 240	12 @ 240	12 @ 240	12 @ 350	12 @ 350
	9.7	12 @ 290	12 @ 290	12 @ 290	12 @ 290	12 @ 410	12 @ 410
	10.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)
	12.2	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
	13.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A Note	DNA
9.1	10.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A Note	Scheme A (Note)	Scheme A (Note)
	12.2	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
	13.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
10.7	12.2	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
	13.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
12.2	13.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA

NOTE – See 910 for details concerning Fire Protection Scheme A.

Table 9.27(d) – Suppression mode sprinklers for rack storage of uncartoned expanded plastics with open shelves

Maximum storage height (m)	**Maximum building height** (m)	**Uncartoned expanded category 5 and 6 plastics**					
		Wet pipe, No. A.S. pressure (kPa)					
		***K* factor 36, 70 °C pendent**	***K* factor 32, 70 °C pendent**	***K* factor 24, 70 °C pendent**	***K* Factor 24, 70 °C upright**	***K* factor 20, 70 °C pendent**	***K* factor 20, 70 °C upright**
6.1	9.0	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	12 @ 690	Scheme A (Note)
7.6	9.1	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	12 @ 690	Scheme A (Note)
	9.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)
	10.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)
	12.2	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
	13.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
9.1	10.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)
	12.2	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
	13.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
10.7	12.2	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
	13.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA
12.2	13.7	Scheme A (Note)	Scheme A (Note)	Scheme A (Note)	DNA	Scheme A (Note)	DNA

NOTE – See 910 for details concerning Fire Protection Scheme A.

Table 9.27(e) – Suppression mode sprinklers for solid-piled, palletised, shelf and bin-box storage of Category 1, 2, 3 and 4 commodities and cartoned unexpanded plastics

Maximum storage height (m)	**Maximum building height** (m)	**Category 1, category 2, category 3, category 4, cartoned unexpanded category 5 and 6 plastics**						
		Wet pipe, No. A.S. pressure (kPa)						
		***K* factor 36, 70 °C pendent (NFPA Design criteria) (Note)**	***K* factor 36, 70 °C pendent (FM Design criteria)**	***K* factor 32, 70 °C pendent**	***K* factor 24, 70 °C pendent**	***K* factor 24, 70 °C upright**	***K* factor 20, 70 °C pendent**	***K* factor 20, 70 °C upright**
7.6	9.1	12 @ 100	12 @ 140	12 @ 170	12 @ 240	12 @ 240	12 @ 350	12 @ 350
	9.7	12 @ 140	12 @ 170	12 @ 210	12 @ 290	12 @ 290	12 @ 410	12 @ 410
	10.7	12 @ 140	12 @ 210	12 @ 240	12 @ 360	12 @ 360	12 @ 520	12 @ 520
	12.2	12 @ 170	12 @ 270	12 @ 310	12 @ 360	DNA	12 @ 520	DNA
	13.7	12 @ 280	12 @ 350	12 @ 350	12 @ 430	DNA	12 @ 620	DNA
9.1	10.7	12 @ 140	12 @ 210	12 @ 240	12 @ 360	12 @ 360	12 @ 520	12 @ 520
	12.2	12 @ 170	12 @ 270	12 @ 310	12 @ 360	DNA	12 @ 520	DNA
	13.7	12 @ 280	12 @ 350	12 @ 350	12 @ 430	DNA	12 @ 620	DNA
10.7	12.2	12 @ 170	12 @ 270	12 @ 310	12 @ 360	DNA	12 @ 520	DNA
	13.7	12 @ 280	12 @ 350	12 @ 350	12 @ 430	DNA	12 @ 620	DNA
12.2	13.7	12 @ 280	12 @ 350	12 @ 350	DNA	DNA	DNA	DNA

NOTE – The design criteria for the sprinklers in this column are not endorsed by FM Global, which developed the data in the rest of this table. The designer is free to make the decision on which column to use for *K*36 sprinklers subject to listing and design brief.

Table 9.27(f) – Suppression mode sprinklers for solid-piled, palletised, shelf and bin-box storage of uncartoned unexpanded plastics

Maximum storage height (m)	**Maximum building height** (m)	**Uncartoned, unexpanded plastics**					
		Wet pipe, No. A.S. pressure (kPa)					
		***K* factor 36, 70 °C pendent**	***K* factor 31, 70 °C pendent**	***K* factor 24, 70 °C pendent**	***K* factor 24, 70 °C upright**	***K* factor 20, 70 °C pendent**	***K* factor 20, 70 °C upright**
7.6	9.1	12 @ 240	12 @ 240	12 @ 240	Scheme A (Note)	12 @ 350	Scheme A (Note)
	9.7	12 @ 290	12 @ 290	12 @ 290	Scheme A (Note)	12 @ 410	Scheme A (Note)
	10.7	12 @ 350	12 @ 350	12 @ 360	Scheme A (Note)	12 @ 520	Scheme A (Note)
	12.2	12 @ 350	12 @ 350	12 @ 360	DNA	12 @ 520	DNA
	13.7	Scheme A (Note)	Scheme A (Note)	12 @ 430	DNA	12 @ 620	DNA
9.1	10.7	12 @ 350	12 @ 350	12 @ 360	Scheme A (Note)	12 @ 520	Scheme A (Note)
	12.2	12 @ 350	12 @ 350	12 @ 360	DNA	12 @ 520	DNA
	13.7	Scheme A (Note)	Scheme A (Note)	12 @ 430	DNA	12 @ 620	DNA
10.7	12.2	12 @ 350	12 @ 350	12 @ 360	DNA	12 @ 520	DNA
	13.7	Scheme A (Note)	Scheme A (Note)	12 @ 430	DNA	12 @ 620	DNA
12.2	13.7	Scheme A (Note)	Scheme A (Note)	DNA	DNA	DNA	DNA

NOTE – See 910 for details concerning Fire Protection Scheme A.

A1

Table 9.27(g) – Suppression mode sprinklers for solid-piled, palletised, shelf and bin-box storage of cartoned, expanded plastic

Maximum storage height (m)	**Maximum building height** (m)	**Cartoned, expanded Category 5 and 6 plastics**					
		Wet pipe, No. A.S. pressure (kPa)					
		***K* factor 36, 70 °C pendent**	***K* factor 32, 70 °C pendent**	***K* factor 24, 70 °C pendent**	***K* factor 24, 70 °C upright**	***K* factor 20, 70 °C pendent**	***K* factor 20, 70 °C upright**
7.6	9.1	12 @ 140	Scheme A (Note 2)	12 @ 240	12 @ 240	12 @ 350	12 @ 350
	9.7	12 @ 210	Scheme A (Note 2)	12 @ 290	12 @ 290	12 @ 410	12 @ 410
	10.7	12 @ 410 (Note 1)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)
	12.2	12 @ 410 (Note 1)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
	13.7	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
9.1	10.7	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)
	12.2	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
	13.7	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
10.7	12.2	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
	13.7	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
12.2	13.7	Scheme A (Note 2)	Scheme A (Note 2)	DNA	DNA	DNA	DNA

NOTE –

(1) This design of 12 @ 410 kPa is applicable only for shelf and bin-box storage, or either solid-piled or palletised storage in a “closed” array.

(2) See 910 for details concerning Fire Protection Scheme A.

A1

Table 9.27(h) – Suppression mode sprinklers for solid-piled, palletised, shelf and bin-box storage of uncartoned expanded plastics

Maximum storage height (m)	Maximum building height (m)	Uncartoned expanded plastics					
		Wet pipe, No. A.S. pressure (kPa)					
		K factor 36, 70 °C pendent	*K* factor 32, 70 °C pendent	*K* factor 24, 70 °C pendent	*K* factor 24, 70 °C upright	*K* factor 20, 70 °C pendent	*K* factor 20, 70 °C upright
6.1	7.6	12 @ 140	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	12 @ 520	Scheme A (Note 2)
	9.1	12 @ 210	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	12 @ 690	Scheme A (Note 2)
	10.7	12 @ 410 (Note 1)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)
	12.2	12 @ 410 (Note 1)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
	13.7	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
7.6	9.1	12 @ 210	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	12 @ 690	Scheme A (Note 2)
	10.7	12 @ 410 (Note 1)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)
	12.2	12 @ 410 (Note 1)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
	13.7	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
9.1	10.7	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)
	12.2	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
	13.7	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
10.7	12.2	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
	13.7	Scheme A (Note 2)	Scheme A (Note 2)	Scheme A (Note 2)	DNA	Scheme A (Note 2)	DNA
12.2	13.7	Scheme A (Note 2)	Scheme A (Note 1)	DNA	DNA	DNA	DNA

NOTE –

(1) This design of 12 @ 410 kPa is applicable only for shelf and bin-box storage, or either solid-piled or palletised storage in a "closed" array.

(2) See 910 for details concerning Fire Protection Scheme A.

910 FIRE PROTECTION SCHEME A

The intent of Fire Protection Scheme A is to allow for the use of a particular sprinkler type, usually either suppression mode or control mode specific application, that is compatible with both the building height and the storage height of a facility, but is not compatible with a small portion of the commodity that is being maintained within the storage area. By segregating the non-compatible commodities into a storage rack and providing the rack with this protection scheme, the remainder of the storage area can then be protected by the particular sprinkler type based on the protection needed for the next lower hazard commodity.

When the protection tables indicate that Fire Protection Scheme A is an option (listed as "Scheme A" in the cell of the table), other options may also be available if the current storage arrangement is either solid-piled or palletised. Other potentially less stringent rack storage arrangements may also be options and should be explored before committing to Fire Protection Scheme A.

Fire Protection Scheme A utilises horizontal barriers in combination with quick-response sprinklers to control the fire.

The horizontal barriers should preferably be noncombustible, using minimum 0.7 mm sheet metal. However, minimum 10 mm plywood can be utilised as well. The barriers should span horizontally the entire width and depth of rack bays, cover all longitudinal flue spaces and have a maximum 75 mm wide opening at rack uprights. Install the barriers vertically at every other tier level, unless the designated rack has solid shelves or the vertical distance between every other tier exceeds 3.7 m. For these conditions install the horizontal barriers at every tier level.

Install minimum *K*11.5 quick-response spray sprinklers beneath each barrier as shown in figures 9.34(a) to (d). The deflector of the sprinkler should be located a maximum distance of 175 mm below the barrier and a minimum of 150 mm above the top of storage.

Figures 9.34(a) to (d) use pallet loads to help represent the proper spacing, positioning and location of in-rack sprinklers. Each pallet load represents a nominal 1.5 m length, both horizontally and vertically. Use the following guidelines as well as the guidelines in 904.2 in combination with the figures to determine the proper spacing, positioning and location of the in-rack sprinklers.

If a figure indicates in-rack sprinklers are needed at every transverse flue space, install the in-rack sprinklers at every transverse flue space. For transverse flue spaces greater than 2.4 m apart, install the in-rack sprinklers at the horizontal midpoints between every transverse flue space as well as at every transverse flue space.

If a figure indicates in-rack sprinklers are needed at every other transverse flue space, install the in-rack sprinklers at every other transverse flue space unless this distance exceeds 3.7 m. If the distance between every other transverse flue space exceeds 3.7 m, install the in-rack sprinklers at every transverse flue space.

Design the in-rack sprinkler system to provide a minimum flow of 230 L/min from each of the most hydraulically remote six sprinklers for single-row racks or eight sprinklers for double-row and multiple-row racks.

With this level of protection, the ceiling sprinkler system does not have to be included in the design outlined above; however it should be capable of providing the required protection for the surrounding occupancy.

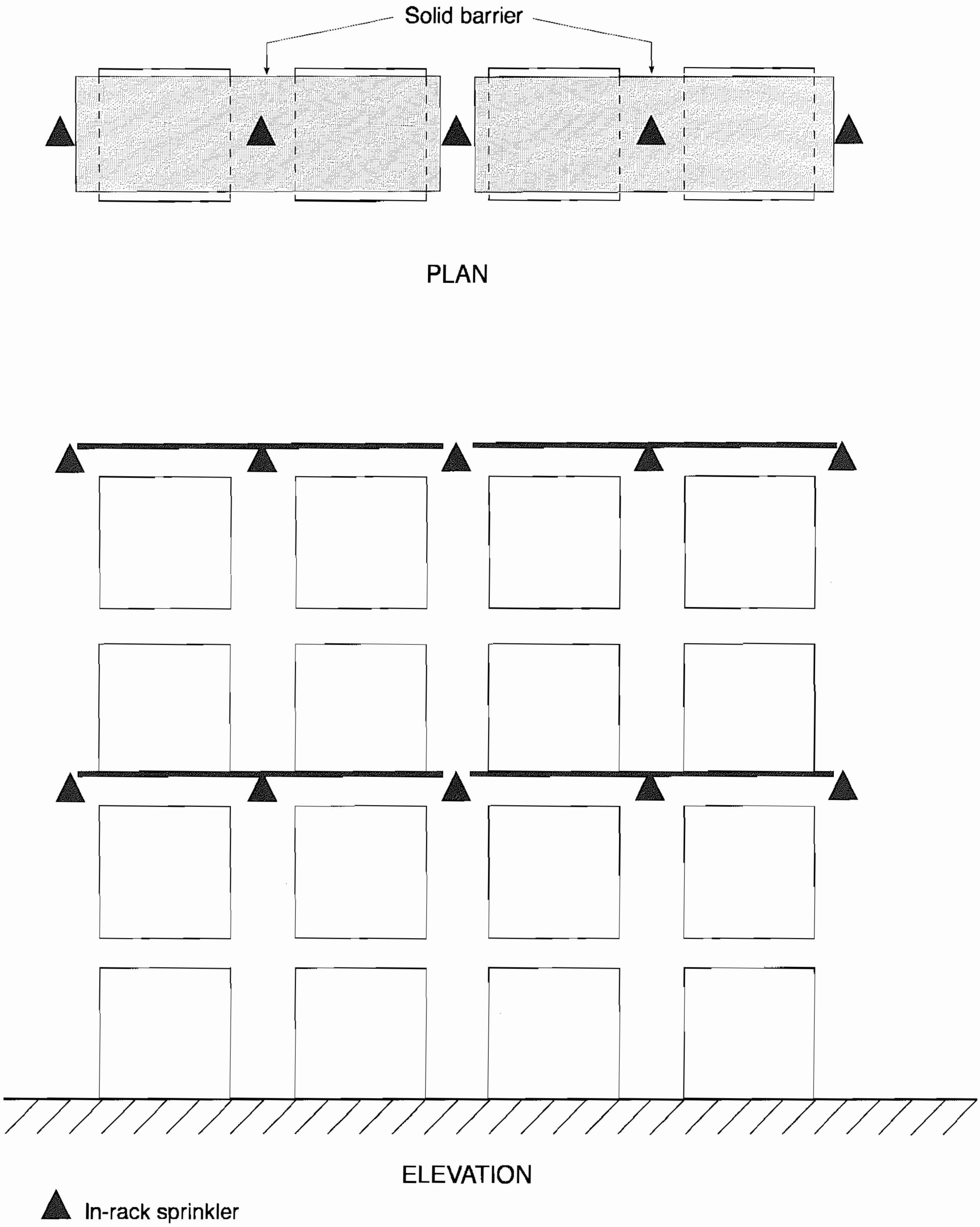


Figure 9.34(a) – Fire protection Scheme A – Using single-row racks (Option A)

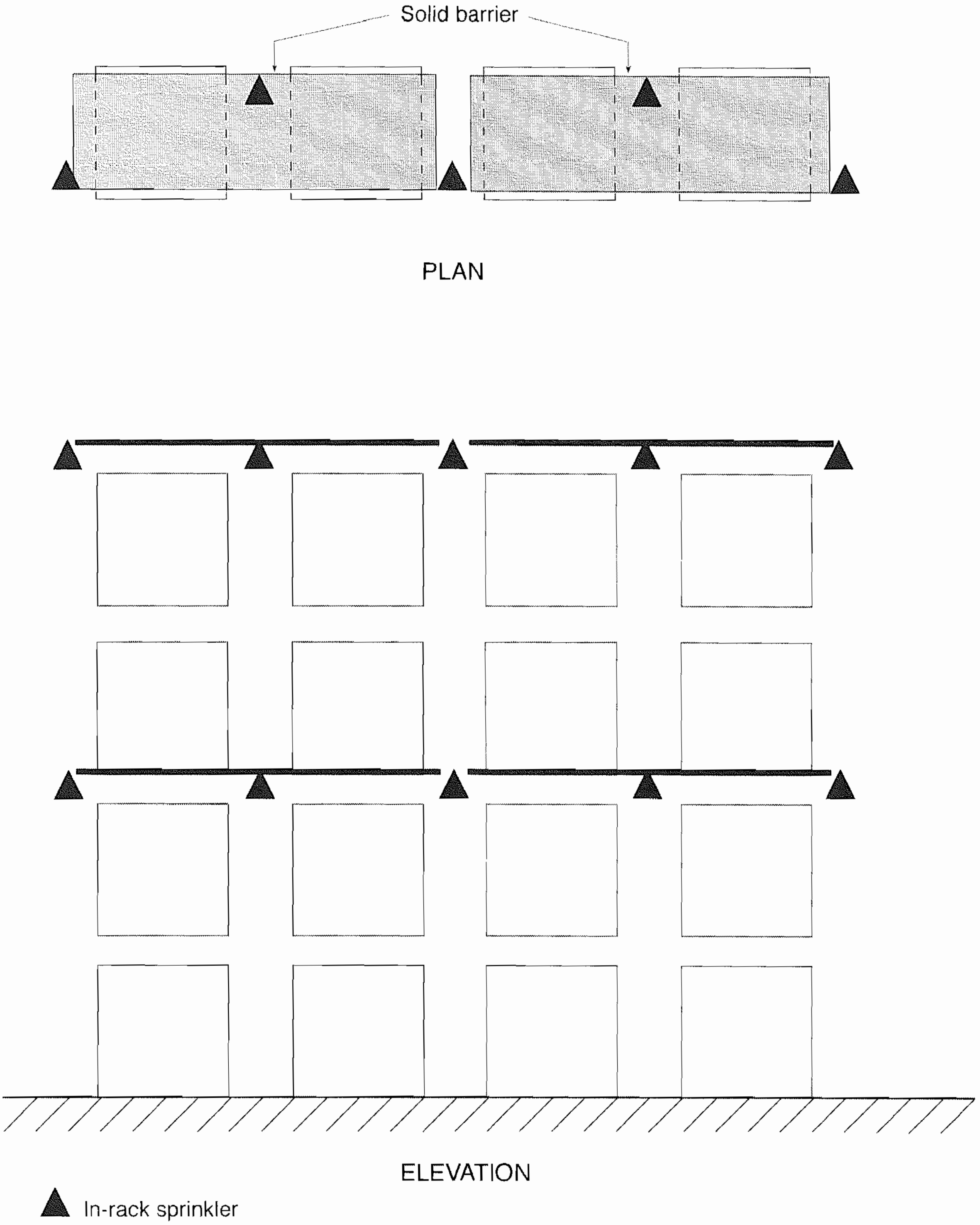
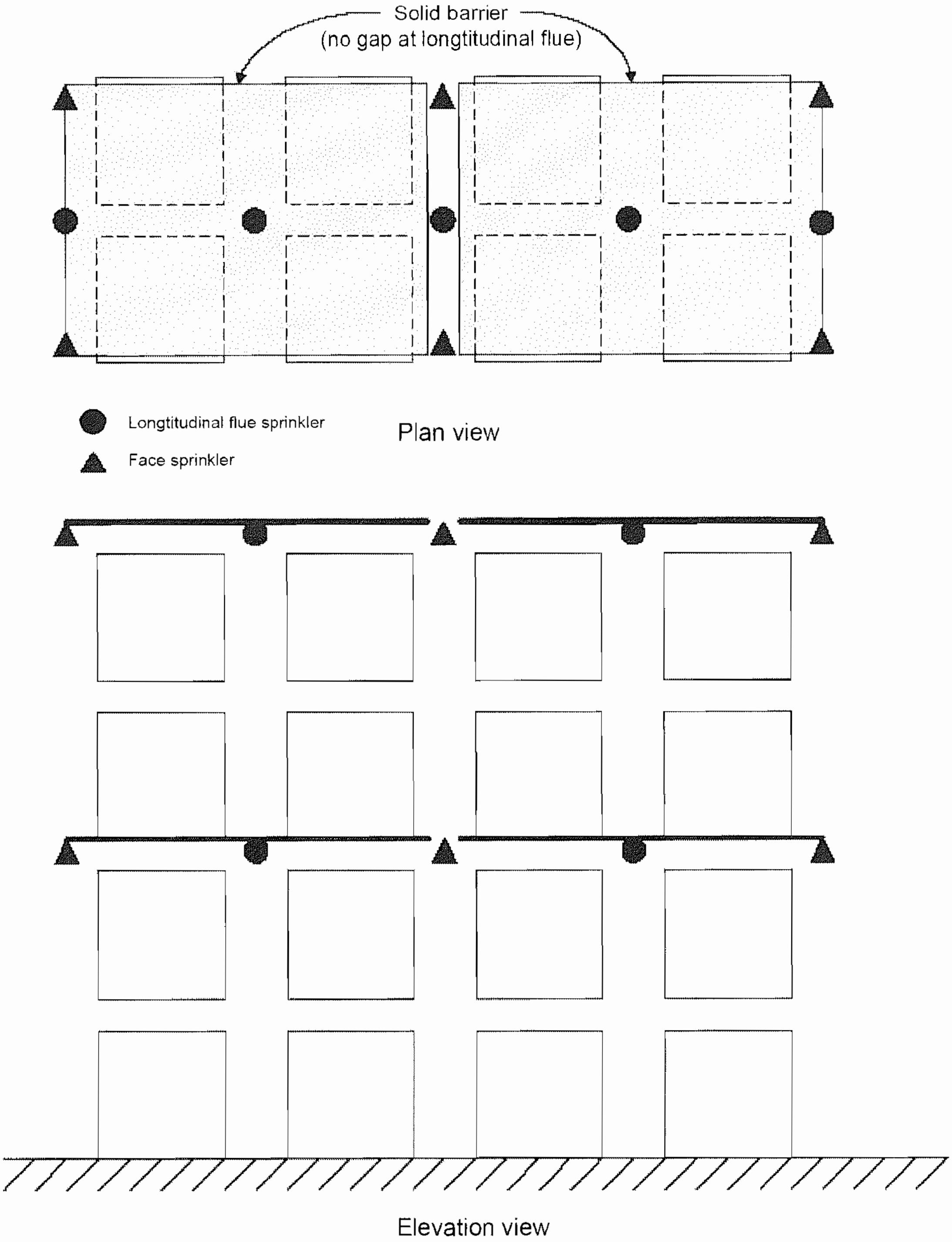


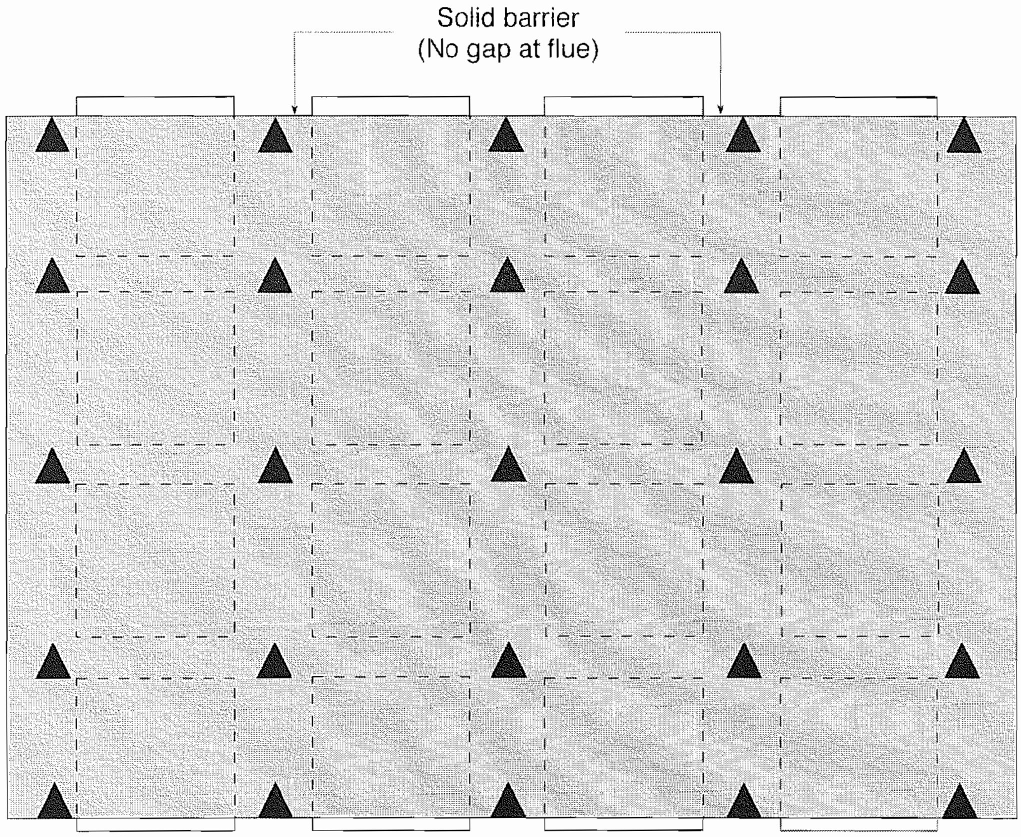
Figure 9.34(b) – Fire protection Scheme A – Using single-row racks (Option B)


Solid barrier
(no gap at longtitudinal flue)
● Longtitudinal flue sprinkler
▲ Face sprinkler

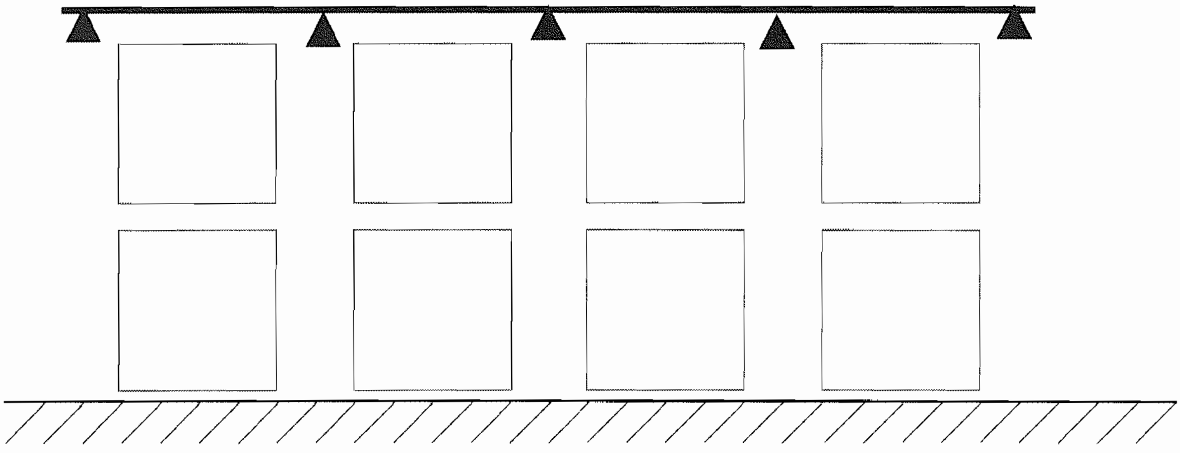
Plan view

Elevation view

Figure 9.34(c) – Fire protection Scheme A – Using double-row racks



PLAN



ELEVATION – FIRST BARRIER LEVEL

▲ In-rack sprinkler

Figure 9.34(d) – Fire protection Scheme A – Using multiple-row racks

Part 10
FULLY HYDRAULICALLY CALCULATED DESIGN

1001 GENERAL

1001.1 Application

1001.1.1
Where permitted by this Standard, the pipework of the entire installation may be sized, using hydraulic calculation of pressure losses, according to the available water supply pressure and the design requirements for the particular installation.

These requirements concern:

(a) Assumed maximum area of operation;

(b) Design density and/or minimum permitted orifice pressure at each sprinkler;

(c) Evenness (or permitted diversity) of design density over the assumed maximum area of operation.

1001.1.2
Fully hydraulically calculated design shall be carried out in accordance with the requirements of this Part.

1001.1.3
This method of design may be used to determine the design of either terminal or looped installations but shall be used on gridded installations.

Where fully hydraulically calculated design is to be used for an area of one class of occupancy, it need not be used for any other area protected by the same installation which represents a less hazardous class of occupancy.

1001.1.4
Generally, gridded methods of design will permit a more economical system. Other parts of this Standard specify the additional information that is required for this type of design.

Dry pipe and preaction installations are not permitted to use gridded design.

1001.2 General calculation method

1001.2.1
For design purposes, the calculation method may be used to determine the necessary water supply characteristics (for example to select a pump size), or it may be used to determine an even and economical design that will fit the available water supply (for example, the characteristics of an existing town's main). It may be advantageous for the designer to have the assistance of a computer that has been programmed to bias one or other of the variables.

For checking purposes, calculation will normally start from the area of operation and work back towards the water supply.

1001.2.2

Generally, the steps to be followed are:

(a) Establish the design density or the minimum end sprinkler flow requirement;

(b) Establish the assumed maximum area of operation, or number of sprinklers to be operated;

(c) Determine the water supply flow and pressure characteristics;

(d) Select sprinkler head spacing and orifice size, and pipe sizes;

(e) Establish the head losses or gains;

(f) Determine the shape and position of the hydraulically most demanding assumed area of operation;

(g) Count the number of sprinklers within that area;

(h) Calculate:

  (i) The flow from each sprinkler in the area of operation, and except where control mode specific application and suppression mode sprinklers are installed, the values are for (ii) and (iii) below

  (ii) The average density over the assumed area of operation

  (iii) The average density over any group of four adjacent sprinklers;

(i) If the calculated values do not meet the relevant requirements of the Standard, the pipe sizes, and/or sprinkler spacing, and/or sprinkler orifice size, and/or water supply characteristics, shall be adjusted.

1001.2.3

It is not necessary to determine the hydraulically most favourable area of operation or, therefore, the maximum water supply demand.

Ultimately, the value of such information relates only to the time that stored water supplies will last and the maximum demand to which the pumps may be subjected.

Both factors assume that in a worst case fire, the most favourably placed areas will impose a larger design flow than the hydraulically most remote area. However, this ignores the tendency for the actual area of operation to decrease as the actual density increases. Hence, in practice, maximum flow tends to be no more than design flow irrespective of the position.

It is not permissible to design on the basis of a smaller area of operation because the possibility of a brief flashfire opening an unusually large number of heads cannot be quantified or, therefore, ignored.

Avoidance of pumps overloading due to excessive flow is provided for in Part 6 in the requirements for pump and motor sizing.

Where stored water supplies are used, extremes of diversity of density across the installation should be avoided to ensure, in the case of a flash fire opening additional sprinklers, that there is sufficient time for the Fire Service to arrive and augment supplies or complete extinguishment.

1002 DESIGN REQUIREMENTS

1002.1 Requirement

1002.1.1

The design density or minimum end sprinkler condition for each area of the protected building is that specified by the relevant sections of Parts 7, 8 or 9, according to the fire hazard present.

1002.1.2

The assumed maximum area of operation shall be determined in accordance with 1003 but shall not be less than that specified by the relevant sections of Parts 7, 8 or 9 as appropriate.

1002.2 Determination of density

The design density shall mean the average density of a group of four adjacent sprinklers within an area of operation.

It shall be calculated from the sum of the flows from the 4 sprinklers (while all other sprinklers in the assumed maximum area are operating) and dividing by 4 times the area of the parallelogram formed by joining the 4 sprinklers. Every such group of four sprinklers shall provide at least the design density.

1002.3 Minimum orifice pressure

1002.3.1

The pressure at any sprinkler, with all sprinklers within the assumed maximum area of operation simultaneously operating, shall not be less than:

In extra light hazard occupancy class:

using 10 mm sprinklers	100 kPa
using 15 mm sprinklers	50 kPa
using residential sprinklers	as per the listing
In ordinary hazard occupancy class	50 kPa
In extra high hazard occupancy class	50 kPa
Where control mode specific application sprinklers are used	see 908
Where suppression mode sprinklers are used	see 909.

1003 DETERMINATION OF AREA OF OPERATION

1003.1 Requirement

In order to determine how many, and which, sprinklers may be operating simultaneously, it is necessary to determine the shape of an area at least the size of the assumed maximum area of operation prescribed by Part 7, 8 or 9. The sprinklers within that area will be considered to be operating simultaneously.

1003.2 General procedure

1003.2.1

Due to possible variations, across the protected area, in sprinkler spacing and the actual area protected by each sprinkler (which may be affected by spacing changes or the proximity of walls, beams or partitions), the shape of the area varies according to its position in the sprinkler configuration. Ridges and deep roof bays which have the effect of channelling heat, will also influence the shape of the area.

Generally, because ultimately only the hydraulically least favourable area is to be considered, the shape will be elongated with the long side (*L*) being to the area (*A*) as follows:

$L \geq 1.2\sqrt{A}$

1003.2.2

For ordinary hazard or extra high hazard occupancies the following steps are required in order to determine the shape of any assumed maximum area of operation:

(a) Determine an approximate average area of coverage for each sprinkler in the area being considered;

(b) Divide the minimum assumed maximum area of operation (1002.1.2) by this average area in order to determine the approximate number of sprinklers likely to operate;

(c) Identify an area, which incorporates that number, of a shape that approximates the ratio $L \geq 1.2\sqrt{A}$ ("remainder" sprinklers will be located just outside the rectangle) where *L* is the dimension along the ranges;

(d) Where necessary, adjust the shape and its orientation (in relation to the direction of the ranges) to take account of fire channelling factors;

(e) Check that the actual area is at least that specified in Part 8 or Part 9 and, if not, increase the number of sprinklers from the approximate number and locate within the general shape requirement.

1003.2.3

For extra light hazard situations where the design density is 2.7 mm/min or where residential sprinklers are installed, see the special provisions of 1003.5.1.

1003.2.4

For suppression mode sprinklers, calculate on the basis of four sprinklers operating on three adjacent ranges.

1003.2.5

For control mode specific application (CMSA) sprinklers see 1003.5.1 for shape of area of operation related to various head numbers.

1003.3 Determining the mean area per sprinkler

1003.3.1

A sufficient number of adjacent sprinklers to be statistically typical shall be selected and the actual area covered by those determined (1003.3.2 and figure 10.1). Division of that area by the number of sprinklers provides the mean area per sprinkler.

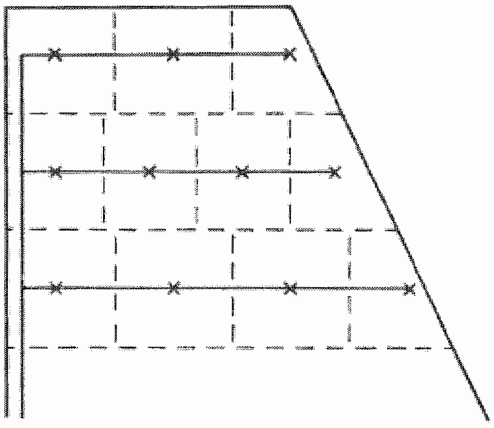


Figure 10.1 – Determination of mean area per sprinkler

1003.3.2

The area covered by sprinklers that are not against walls or partitions, shall extend from lines midway between the sprinkler and the line of sprinklers on one side, to a line midway between the sprinkler and the line of sprinklers on the opposite side.

1003.3.3

The area covered by sprinklers that are against walls or partitions shall extend from the wall or partition to lines midway between and parallel to the adjacent lines of sprinklers (or, on the same range, adjacent sprinkler) and the sprinkler under consideration.

1003.4 Determining the number of sprinklers within the assumed area of operation

1003.4.1

The number of sprinklers (*N*) used to determine the assumed area of operation shall initially be determined by dividing the assumed maximum area of operation (Part 7, 8 or 9) by the mean area per sprinkler, and rounding that result up to the next whole number.

If a statistically typical group of sprinklers was considered in determining the mean area per sprinkler, then the number of sprinklers (*N*) is to be recalculated as required by 1003.6.

1003.5 Determining the shape of the area of operation

1003.5.1

The assumed maximum area of operation which shall be generally rectangular shall enclose the number of sprinklers (*N*) assumed to be in simultaneous operation and shall be shaped according to the following formulae (and as illustrated in figure 10.2):

$$N_a = \frac{1.2\sqrt{A}}{S} \quad \text{(rounded up to the next whole number)}$$

$$N_b = \frac{N}{N_a}$$

$$r = N - (N_a \times N_b)$$

where

N_a = Number of sprinklers on those ranges within the rectangular portion of the area of operation
N_b = Number of ranges within the rectangular portion of the area of operation
A = Assumed maximum area of operation
r = Remainder sprinklers not within the rectangular portion
S = Mean spacing of sprinklers on the ranges under consideration.

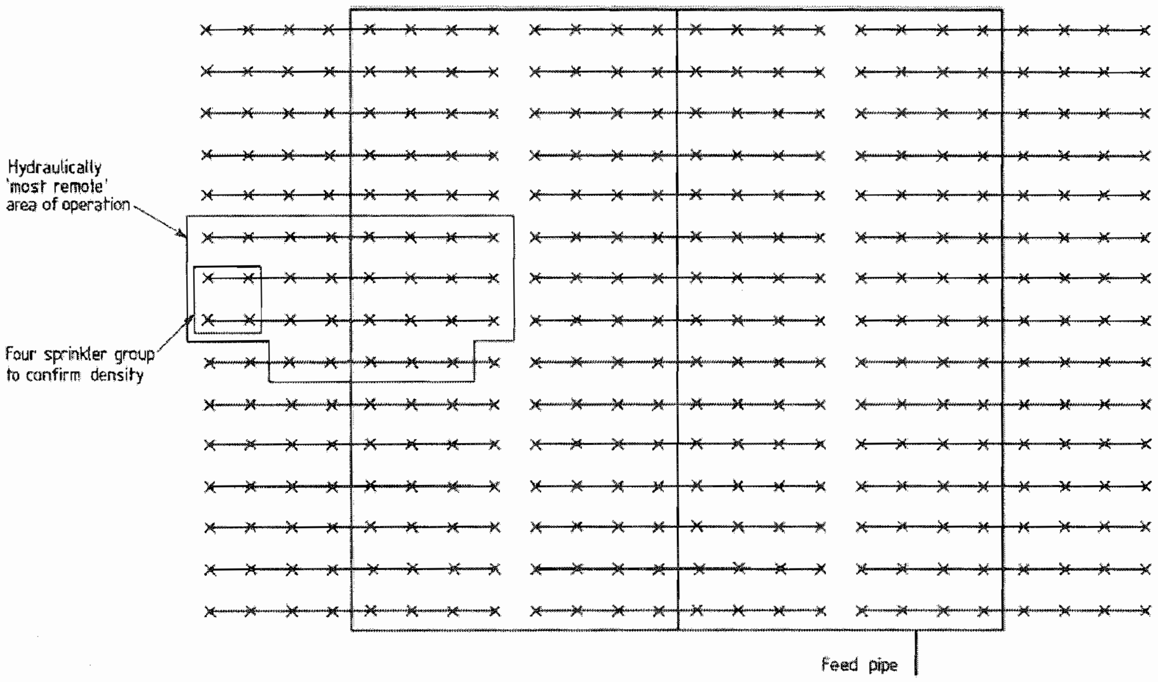

Hydraulically 'most remote' area of operation
Four sprinkler group to confirm density
Feed pipe

Figure 10.2 – Location and shape of hydraulically "most remote" area of operation

For extra light hazard occupancies using standard coverage spray type heads, the design area shall be as outlined in 701.1.

For extra light hazard occupancies using residential sprinklers the area of operation shall include all sprinklers within a room to a maximum of four sprinklers. When a room contains fewer than four sprinklers, the number of design sprinklers shall include all sprinklers in that room plus sprinklers in adjoining rooms to a total of four sprinklers. In all cases the design area shall include the most hydraulically demanding group of four sprinklers.

For the purposes of determining the area of operation a "room" shall mean a space enclosed by walls, ceiling (or roof) and floor (including a cupboard) provided that any door opening does not exceed 2 metres in width and incorporates a lintel at least 300 mm deep.

For CMSA sprinklers the shape of the sprinklers in operation shall be as follows:

(a) 15 heads shall be 5 heads on 3 adjacent ranges;

(b) 18 heads shall be 6 heads on 3 adjacent ranges;

(c) 20 heads shall be 5 heads on 4 adjacent ranges;

(d) 25 heads shall be 5 heads on 5 adjacent ranges;

(e) 30 heads shall be 6 heads on 5 adjacent ranges;

(f) 36 heads shall be 6 heads on 6 adjacent ranges.

Where the design number for suppression mode sprinklers is 12 there shall be 4 sprinklers operating on 3 adjacent ranges.

1003.5.2

Where N_a is less than the number of sprinklers on the range under consideration, the sprinklers considered as N_a shall be those that are hydraulically most remote.

1003.5.3

If single ranges on end-side arrangements, or pairs of opposite ranges on end-centre arrangements have fewer than N_a sprinklers, N_a shall be changed to the actual number of sprinklers on each range or range pair.

The values of N_b and r will change accordingly.

1003.5.4

Sprinklers that constitute the remainder (r) shall be placed on the next range or, with end-centre arrangements, on the next pair of opposite ranges, in a position that is alongside the area N_a x N_b in a position that maximises the flow required.

1003.5.5

If ranges within an area of operation are run horizontally along a sloping roof of gradient 1 in 4 or greater, N_a shall be adjusted for the 2 highest ranges (or 3, if there is a range at the apex) to be either 15 or the actual number of sprinklers on the range under consideration – whichever is the least.
N_b and r will be recalculated accordingly.

1003.6 Confirmation of the mean area per sprinkler

1003.6.1

In order to confirm that the number of sprinklers (N) is not too few as a result of taking a statistically atypical number of sprinklers when determining the mean area per sprinkler, the actual area of the shape established shall be measured.

1003.6.2

If that actual area is less than the assumed maximum area of operation (A), the number (N) shall be increased by one, or more, and new values shall be established for N_a, N_b and r, and a new shape determined.

1003.6.3

The actual area of the new shape shall be measured and again checked against the area A and, if necessary, N shall again be adjusted – the process being repeated until the actual area is equal to or greater than A.

1003.7

Where additional sprinkler heads are installed, which may operate in addition to those designed to control the fire load, then these are to be designed to operate in addition to the heads in the area of operation.

One example of such heads includes those provided to wet internal glazing, with no significant water distribution onto the floor. The design number of heads shall be those bounding the hydraulically most onerous area of operation, where such heads are installed.

A second example is where heads are installed below perforated decks and ceilings, to comply with 512.3.2, a Sprinkler System Certifier (SSC) may require that these be included in the hydraulic calculations.

1003.8 Design requiring special consideration

1003.8.1 *Belt conveyors*

For belt conveyors with a slope of less than 10°, allow for 10 x 15 mm sprinklers to operate at a minimum head pressure of 70 kPa. Where the slope exceeds 10°, allow for 15 x 15 mm sprinklers to operate at a minimum head pressure of 70 kPa.

NOTE – FM Global Data Sheet 7-11 provides advice on best practice for belt conveyor protection.

1004 DETERMINATION OF DESIGN FLOW AND PRESSURE

1004.1 Requirement

1004.1.1

The design flow and pressure at the sprinkler valves for a fully hydraulically calculated installation shall be that which is required to support the hydraulically worst-placed area of operation (including an allowance for any difference of pressure due to head).

1004.1.2

For systems designed to protect an ordinary hazard occupancy the assumed maximum area of operation shall be not be less than that specified in 801.1. However, for determining the minimum storage capacity for any storage tank (606.1) the design flow may be assumed to be 540 L/min for OH1 and 1,000 L/min for OH2.

1004.2 Determination of the hydraulically worst-placed area of operation

1004.2.1

On each distribution pipe, and on gridded pipe configurations, between distribution pipes, an assumed maximum area of operation (determined in accordance with 1003) shall be nominated as the hydraulically worst-placed such area.

Any such area which is similar to another under consideration, may be ignored.

Conversely, any area which, due to changes in sprinkler spacing, elevation, range centres or pipe sizes, appears to impose a greater hydraulic demand, shall also be nominated.

1004.2.2

The hydraulic demand (pressure required at the design flow) for each candidate area shall be determined by calculation in accordance with 1005.

1004.2.3

Proof that each candidate area is the hydraulically worst-placed in the general area chosen, shall be obtained. This may generally be done by displacing the candidate area by one sprinkler along the range and by one range in each direction, or by showing that the lowest discharging sprinkler is not on the perimeter of the cover.

1004.2.4

The candidate area imposing the greatest hydraulic demand, shall be deemed the hydraulically worst-placed area.

1005 METHOD OF CALCULATION

1005.1 Accuracy

1005.1.1

The following dimensions shall be expressed in the units and to the accuracies below:

Dimension	Unit	Accuracy
Length & elevations	m	3 significant figures
	mm	Nearest whole unit
Flow rate	L/min	Nearest whole unit
Pressure	kPa	Nearest whole unit
Discharge density	mm/min	1 decimal place
Area	m^2	3 significant figures

1005.1.2

Flows merging into a junction shall be estimated to within ±2 L/min of flows emerging from the junction.

1005.1.3

When estimating the flows and pressure losses in each direction around a ring main or section of gridded network, the maximum acceptable difference in calculated pressure at any junction is 1.0 kPa.

1005.1.4

The discharge from a sprinkler shall be calculated to within ±1 L/min using the formula and K factors set out in 1005.5.

1005.1.5

To check for the effect of cumulative errors the sum of the flows from the individual sprinklers shall be determined and shall be within ±1 % of the calculated design flow.

1005.2 Calculation of static pressure head

The static pressure equivalent of differences in height between sprinklers, junctions and datums etc. is to be taken as:

$$P = h \times 10$$

where

P = pressure gain or loss due to head (kPa)
h = difference in height between sprinklers, junctions and datums (m).

1005.3 Calculation of pressure loss in pipes

1005.3.1

Pressure losses due to water flow through pipes shall be determined using one of the following formulae in 1005.3.2 or 1005.3.3, as appropriate.

NOTE – It is not a requirement of this Standard to limit water velocity in pipes.

1005.3.2

Pressure losses in all types of pipe may be calculated using the Hazen-Williams formula:

$$P = \frac{0.605 \times Q^{1.85} \times 10^{8}}{C^{1.85} \times d^{4.87}}$$

where

P = loss of pressure per metre of pipe (kPa/m)
Q = flow rate of water through pipe length (L/min)
d = mean bore diameter (mm)
C = a constant for the type of pipe i.e.

Cast iron	$C = 100$
Steel, galvanised after fabrication	C = 110
Steel, black or galvanised	C = 120
Steel, spun concrete lined	C = 130
Copper, MPVC, UPVC and PE pipes	C = 140
Chlorinated PVC	C = 150.

1005.3.3

Pressure losses in each metre of steel or CPVC pipe may be calculated using the simplified formula:

$$P = R\,Q^{1.85}$$

where

P = loss of pressure per metre of pipe (kPa)
Q = flow rate of water through pipe length (L/min)
R = the appropriate value from table 10.1

Table 10.1 – Values of *R* for steel and chlorinated PVC pipes

Nominal bore	**Steel pipe**		**Steel pipe to AS 1074 or BS 1387**				**Chlorinated PVC to ASTM F442**	
	Light to AS/NZS 2642		**Medium grade**		**Heavy grade**			
(mm)	**Mean i.d.** (mm)	**Value of *R***	**Mean i.d.** (mm)	**Value of *R***	**Mean i.d.** (mm)	**Value of *R***	**Mean i.d.** (mm)	**Value of *R***
20	–	–	21.63	2.71×10^{-3}	20.41	3.60×10^{-3}	22.2	1.58×10^{-3}
25	29.7	5.79×10^{-4}	27.31	8.73×10^{-4}	25.68	1.18×10^{-3}	28.0	5.11×10^{-4}
32	38.2	1.7×10^{-4}	35.97	2.28×10^{-4}	34.34	2.86×10^{-4}	35.4	1.63×10^{-4}
40	43.7	8.83×10^{-5}	41.86	1.09×10^{-4}	40.23	1.32×10^{-4}	40.6	8.37×10^{-5}
50	55.7	2.71×10^{-5}	52.98	3.46×10^{-5}	51.36	4.02×10^{-5}	50.9	2.78×10^{-5}
65	71.5	8.03×10^{-6}	68.67	9.78×10^{-6}	67.04	1.10×10^{-5}	61.5	1.09×10^{-5}
80	83.7	3.73×10^{-6}	80.68	4.46×10^{-6}	79.06	4.92×10^{-6}	75.0	4.18×10^{-5}
100	108.2	1.07×10^{-6}	105.14	1.23×10^{-6}	103.31	1.34×10^{-6}	–	–
150	158.3#	1.67×10^{-7}	155.32	1.84×10^{-7}	154.30	1.90×10^{-7}	–	–
200	–	–	209.54*	4.27×10^{-8}	208.30**	4.40×10^{-8}	–	–
250	–	–	263.44*	1.40×10^{-8}	258.80**	1.53×10^{-8}	–	–

NOTE –

(1) * API 5L pipe 4.78 mm wall thickness for 200 mm and 250 mm.

(2) ** BS 3600 thickness 5.4 mm for 200 mm pipe and 7.1 mm for 250 mm pipe.

(3) # AS 4118 pipe 3.4 mm wall thickness.

A1

1005.4 Pressure loss in fittings and valves

1005.4.1

Loss of pressure, due to water flow through pipe elbows, tees and bends where the direction of water flow is changed through an angle of 45° or more (other than the change of direction into a sprinkler or sprinkler assembly or drop from an elbow or tee into which the sprinkler or sprinkler assembly is fitted), shall be calculated by multiplying the appropriate factor from the following table by the nominal diameter in mm of the smallest pipe in the fittings waterway. The length in metres of equivalent straight pipe thus derived shall be added to the actual lengths of pipe under consideration for use in the above pressure loss formulae.

Hazen-Williams factor (C)	**100**	**110**	**120**	**130**	**140**	**150**
Tees into branches	0.040	0.050	0.060	0.070	0.080	0.090
Elbows	0.020	0.025	0.030	0.035	0.040	0.045
Bends*	0.010	0.0125	0.015	0.0175	0.020	0.0225

* A bend is any fitting where the radius divided by nominal pipe diameter is greater than 1.5.

1005.4.2

Loss of pressure due to water flow through alarm valves, back pressure valves, stop valves etc. shall be calculated using the formula:

$$P=\left(\frac{Q}{K}\right)^2$$

where K is the loss factor associated with the listing for the particular size and type of valve.

1005.5 Calculation of discharge from a sprinkler

The discharge from a sprinkler shall be calculated using the following formula:

$$Q=K\sqrt{P}$$

where

Q = Discharge from sprinkler (L/min)
P = Pressure at entry to sprinkler orifice (kPa)
K = Sprinkler discharge co-efficient, using the following values:

K = 2.0 L/min (kPa)$^{-0.5}$
K = 3.0 L/min (kPa)$^{-0.5}$
K = 4.0 L/min (kPa)$^{-0.5}$
K = 5.7 L/min (kPa)$^{-0.5}$
K = 8.0 L/min (kPa)$^{-0.5}$
K = 11.5 L/min (kPa)$^{-0.5}$
K = 16.0 L/min (kPa)$^{-0.5}$
K = 20.0 L/min (kPa)$^{-0.5}$
K = 24.0 L/min (kPa)$^{-0.5}$
K = 28.0 L/min (kPa)$^{-0.5}$
K = 32.0 L/min (kPa)$^{-0.5}$
K = 36.0 L/min (kPa)$^{-0.5}$
K = 40.0 L/min (kPa)$^{-0.5}$

Residential sprinklers .... as per manufacturer's listing
Other types of sprinklers .... as per manufacturer's listing.

To ensure that system performance is not compromised by substitution of differing manufacturer sprinklers, nominal K factors as defined above must be used in hydraulic calculations.

1005.6 Calculation of flow from identical ranges

For the purpose of calculating the design flow for terminal pipe configurations, the flow from more favourably placed identical ranges may be determined by the formula:

$$Qr=C\sqrt{Pn}$$

where

C = flow in the first range divided by the square root of the junction pressure at start of that range
Pn = junction pressure of the range under consideration
Qr = flow in the range under consideration.

1005.7 Velocity head

The velocity head may be ignored in these hydraulic calculations. If the velocity head is used, it shall be incorporated in calculations for all distribution and range pipes.

1006 DOCUMENTATION

1006.1 Preliminary stage

The contractor shall supply to a SSC the information required by 112.1.

1006.2 At completion

Prior to final inspection, and in accordance with 112.2, the contractor shall supply a SSC with the following:

(a) As-built sprinkler and pipe layout plans which show the following:
   (i) A node, or pipe reference system, that provides unique identification for pipes, bends, junctions, sprinkler heads and other pipe fittings which require hydraulic consideration
   (ii) Distribution pipes and diameters
   (iii) Type of pipes used and "C" factor
   (iv) Range pipes that require hydraulic consideration and diameter
   (v) Sprinkler heads within each assumed maximum area of operation
   (vi) The position of the hydraulically worst-placed assumed maximum area of operation
   (vii) Nominated worst group of 4 sprinklers within the worst-placed assumed maximum area of operation to demonstrate diversity adequacy
   (viii) Flow through each sprinkler and pipe between junctions
   (ix) Pressures at each end of each pipe and at the entry to each sprinkler assumed to be operating
   (x) Height of each such node above or below datum;

(b) Calculation data sheets and/or computer print-outs to support the installation schematic diagrams and plans. For gridded and looped installations, these data shall be provided for each sample (candidate) area of operation considered (1004.2);

(c) The following details for each operating sprinkler in each candidate area:
   (i) Node or reference number
   (ii) Nominal orifice size
   (iii) Flow from sprinkler (L/min)
   (iv) Pressure at entry to sprinkler (kPa)
   (v) For residential sprinklers, a copy of the manufacturer's current data sheet;

(d) The following details for each hydraulically significant pipe:
   (i) Node or reference number
   (ii) Nominal bore diameter (mm)
   (iii) Formula used to determine pressure loss (1005.3)
   (iv) Flow through pipe (L/min)
   (v) Length (m)
   (vi) Number of tees, elbows, crosses and other hydraulically significant fittings
   (vii) Total hydraulic length
   (viii) Static head change in pipe
   (ix) Pressure at each end of pipe
   (x) Friction loss in pipe (kPa)
   (xi) Direction of flow.

Part 11
PRECAUTIONS TO BE TAKEN WHEN AN INSTALLATION IS RENDERED INOPERATIVE

1101 GENERAL

Sprinkler systems may be rendered inoperative from time to time to effect maintenance, repairs or alterations. The contractor shall follow the procedures and take the precautions specified in this section and any others required by a Sprinkler System Certifier (SSC).

1102 NOTIFICATION

1102.1

Before a sprinkler system is rendered inoperative, notification in writing shall be delivered to the building owner or his/her agent or representative and the Fire Service or their authorised monitoring agent 24 hours in advance of the work commencing. The building owner shall be advised to inform their insurers of any isolation that exceeds 12 hours.

If an emergency compels immediate action to render the system inoperative, such notifications shall be given as soon as possible thereafter.

1102.2

Notification to the building owner or his/her agent or representative shall include the following information:

(a) Name and address of premises;

(b) Reason for rendering system inoperative;

(c) Date and times the system will be off;

(d) Details of extension or alteration work;

(e) Whether “frying pans” or sectional valves will be used to isolate a section or zone of a system;

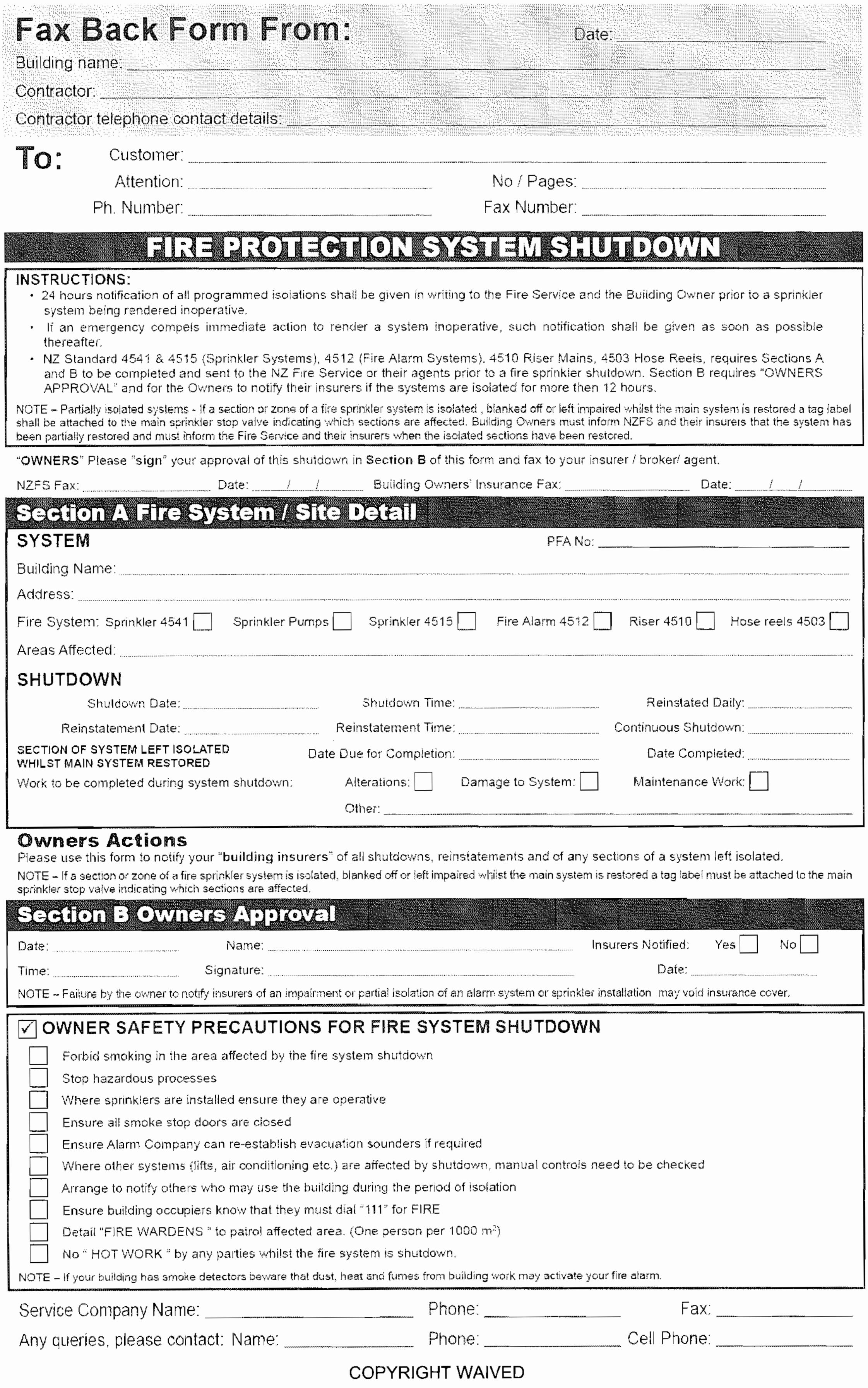
(f) Whether the work will involve cutting or welding and, if so, the precautions that will be taken.

Notification to the Fire Service shall include items (a) to (e).

The building owner shall be advised to inform their insurers of items (a) to (f).

NOTE – Information may be provided in the form shown in figure 11.1.

A tag label as shown in figure 11.2 or similar shall be used to identify sections of a sprinkler system left isolated.



Fax Back Form From:

Date: ______

Building name: ______

Contractor: ______

Contractor telephone contact details: ______

To:

Customer: ______

Attention: ______ No / Pages: ______

Ph. Number: ______ Fax Number: ______

FIRE PROTECTION SYSTEM SHUTDOWN

INSTRUCTIONS:

- 24 hours notification of all programmed isolations shall be given in writing to the Fire Service and the Building Owner prior to a sprinkler system being rendered inoperative.
- If an emergency compels immediate action to render a system inoperative, such notification shall be given as soon as possible thereafter.
- NZ Standard 4541 & 4515 (Sprinkler Systems), 4512 (Fire Alarm Systems), 4510 Riser Mains, 4503 Hose Reels, requires Sections A and B to be completed and sent to the NZ Fire Service or their agents prior to a fire sprinkler shutdown. Section B requires "OWNERS APPROVAL" and for the Owners to notify their insurers if the systems are isolated for more then 12 hours.

NOTE – Partially isolated systems - If a section or zone of a fire sprinkler system is isolated , blanked off or left impaired whilst the main system is restored a tag label shall be attached to the main sprinkler stop valve indicating which sections are affected. Building Owners must inform NZFS and their insurers that the system has been partially restored and must inform the Fire Service and their insurers when the isolated sections have been restored.

"**OWNERS**" Please "**sign**" your approval of this shutdown in **Section B** of this form and fax to your insurer / broker/ agent.

NZFS Fax: ______ Date: __/__/__ Building Owners' Insurance Fax: ______ Date: __/__/__

Section A Fire System / Site Detail

SYSTEM

PFA No: ______

Building Name: ______

Address: ______

Fire System: Sprinkler 4541 ☐ Sprinkler Pumps ☐ Sprinkler 4515 ☐ Fire Alarm 4512 ☐ Riser 4510 ☐ Hose reels 4503 ☐

Areas Affected: ______

SHUTDOWN

Shutdown Date: ______ Shutdown Time: ______ Reinstated Daily: ______

Reinstatement Date: ______ Reinstatement Time: ______ Continuous Shutdown: ______

SECTION OF SYSTEM LEFT ISOLATED WHILST MAIN SYSTEM RESTORED Date Due for Completion: ______ Date Completed: ______

Work to be completed during system shutdown: Alterations: ☐ Damage to System: ☐ Maintenance Work: ☐

Other: ______

Owners Actions

Please use this form to notify your "**building insurers**" of all shutdowns, reinstatements and of any sections of a system left isolated.

NOTE – If a section or zone of a fire sprinkler system is isolated, blanked off or left impaired whilst the main system is restored a tag label must be attached to the main sprinkler stop valve indicating which sections are affected.

Section B Owners Approval

Date: ______ Name: ______ Insurers Notified: Yes ☐ No ☐

Time: ______ Signature: ______ Date: ______

NOTE – Failure by the owner to notify insurers of an impairment or partial isolation of an alarm system or sprinkler installation may void insurance cover.

☑ OWNER SAFETY PRECAUTIONS FOR FIRE SYSTEM SHUTDOWN

- ☐ Forbid smoking in the area affected by the fire system shutdown
- ☐ Stop hazardous processes
- ☐ Where sprinklers are installed ensure they are operative
- ☐ Ensure all smoke stop doors are closed
- ☐ Ensure Alarm Company can re-establish evacuation sounders if required
- ☐ Where other systems (lifts, air conditioning etc.) are affected by shutdown, manual controls need to be checked
- ☐ Arrange to notify others who may use the building during the period of isolation
- ☐ Ensure building occupiers know that they must dial "111" for FIRE
- ☐ Detail "FIRE WARDENS " to patrol affected area. (One person per 1000 m^2)
- ☐ No " HOT WORK " by any parties whilst the fire system is shutdown.

NOTE – If your building has smoke detectors beware that dust, heat and fumes from building work may activate your fire alarm.

Service Company Name: ______ Phone: ______ Fax: ______

Any queries, please contact: Name: ______ Phone: ______ Cell Phone: ______

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Figure 11.1 – Typical form for notifying that an installation is to be rendered inoperative

Part A

Impairment notice number:

Date: _____/______/_______

Contractor: ______________________

Work permit number: ______________

Sprinkler system number ___________ **isolated**

Part B

Section of sprinkler system isolated:
(Give location of isolated valve or blanking plate used) and area of building not covered)

____
____
____
____

Date of isolation: ____/_____/_______

Proposed date of reinstatement:
____/_____/____

Contractor: ______________________

Signed: __________________________

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Figure 11.2 – Typical form for isolation tag card

The tag card shall be affixed by the contractor to the main sprinkler stop valve.

Part A shall be completed whenever a sprinkler system is isolated and the valve house left unattended.

When a section or zone of a sprinkler system is isolated, Part B shall be completed by the contractor and the isolation card affixed to the Main Stop Valve. The card shall remain attached to the main stop valve until the whole system is restored.

1102.3
No sprinkler system or sprinkler water supply shall be altered or rendered permanently disabled without a building consent for the work being issued by the TA or BCA and a SSC informed.

NOTE – In order to ensure that the users of the building are not misled, it is recommended that if a sprinkler system is rendered permanently disabled, that obvious indications of sprinkler protection are removed. This would include the removal of sprinkler heads, water motor alarm gongs and signage indicating the presence of sprinkler protection.

1103 AUTHORISATION

1103.1

Except in an emergency, the system shall not be rendered inoperative until the owner or their authorised representative has authorised the work by signing the appropriate section of the form set out in figure 11.1.

Where possible 24 hours prior notice shall be provided for system alterations, routine servicing and maintenance isolations.

1103.2

A copy of the signed authorisation shall be forwarded to a SSC.

1104 HOT WORK

Cutting or welding involving hot work should normally not be carried out on the sprinkler system. It shall not be carried out without the contractor first obtaining specific approval from the Building Owner. Such approval, if granted, may specify precautions to be taken by the contractor to minimise the risk of ignition while the installation is inoperative.

These precautions will normally include:

(a) Having charged hose reels or suitable types of extinguishers on hand;

(b) Removing or covering combustibles in the immediate vicinity of the work;

(c) Posting a watchman during the actual hot work;

(d) Re-checking the area 30 minutes after completion of the hot work;

(e) Complying with NZS 4781 where cutting or welding is undertaken.

1105 SECTIONAL VALVES

1105.1

Where provided, sectional valves should be used if practicable to keep to a minimum the area in which the sprinkler installation is inoperative.

1105.2

Great care shall be used to ensure that sectional valves are reopened after completion of the work.

NOTE – Clause 1102.2 provides requirements for use of isolation tags when zones or sections of a sprinkler system is isolated.

1106 BLANKING PIECES

1106.1

Blanking pieces or “frying pans” inserted between the flanges of a pipe joint may be used to isolate temporarily sections of a sprinkler installation.

NOTE – Clause 1102.2 provides requirements for use of isolation tags when zones or sections of a sprinkler system is isolated.

1106.2
"Frying pans" shall be cut from a single piece of sheet steel or the handle shall be welded. The handle shall:

(a) Project at least 300 mm from the edge of the pan;

(b) Be painted with fluorescent paint;

(c) Be stamped and painted with an identification number;

(d) Be drilled and, when used in a concealed space, be connected with a coloured tag of sufficient length to be clearly visible from the occupied area of the building.

1106.3
Where screwed plugs, screwed or grooved end caps or blank flanges are used for temporary isolation, a coloured tag of sufficient length shall be attached so as to be clearly visible from the occupied area of the building. This tag shall have stencilled on it the words "Temporary Sprinkler Isolation".

NOTE – If a section or zone of a fire sprinkler system is isolated, blanked off or left impaired while the main system is restored a tag label shall be attached to the sprinkler main stop valve indicating which sections are affected.

1106.4
The contractor shall maintain a written record of the use of all "frying pans" and isolation tags and such records shall be available for inspection by a SSC.

1106.5
Discs inserted in union joints to effect temporary isolation are not permitted.

1107 WATER SUPPLIES

1107.1
In the event of all the water supplies of a sprinkler system becoming inoperative for a long period, a temporary supply through the fire brigade inlet should be arranged if practicable.

1107.2
In the event of town's main supplies becoming inoperative through drought or other reason, special attention should be given to keeping any other supply in efficient working condition.

In the event a water supply to a sprinkler system is rendered inoperative, notification in writing shall be delivered to the building owner or their agent or representative and the Fire Service or their authorised monitoring agent 24 hours in advance of the work commencing. If an emergency compels immediate action to render the system inoperative, such notification shall be given as soon as possible thereafter.

The building owner shall be advised to inform their insurers of any impairment of a water supply.

Part 12
ROUTINE TESTING, MAINTENANCE AND INSPECTIONS

1201 GENERAL

1201.1

The system shall be maintained in efficient working order. Regular tests and inspections shall be made as specified in this Part to ensure that the building is adequately protected and that the system is in efficient working order. There shall be a testing contract with a listed contractor to ensure that the control and alarm equipment is regularly tested. A sprinkler system shall not be deemed to comply with this Standard unless, after completion of installation, it is tested, maintained and inspected on a regular basis by a contractor, in the manner set out in this Part.

To allow a Contractor to issue a Compliance Certificate in order for a Building Warrant of Fitness to be issued, the Contractor must be satisfied that the system is performing, and will continue to perform in accordance with the design requirements of the original Standard to which the system was installed. All deficiencies must be rectified in a timely manner, taking cognisance of the impact that the deficiency will have on the probability that the system's performance will be compromised.

NOTE –

(1) A Compliance Certificate is commonly referred to as a "Form 12A" as defined in the Building (Forms) Regulations.

(2) Significant deficiencies which would lead to a significant probability of system failure should be urgently attended to, to ensure that the system will operate reliably. Examples of such deficiencies include a significant deficiency in the water supply, or a significant increase in the fire load beyond the capability of the system. A Compliance Certificate should not be issued if such deficiencies exist.

(3) Minor deficiencies which are in the process of being rectified should not preclude the ability to issue a Compliance Certificate. Such deficiencies could include a minor water supply deficiency, individual areas with heads out of rule, pressure gauges requiring recalibration and the like. If such deficiencies appear on subsequent inspection reports, a Compliance Certificate should not be issued until such deficiencies are rectified.

(4) An element of judgment may be required in ascertaining if other deficiencies should preclude the issuing of a Compliance Certificate.

To give effect to this requirement, the owner of the sprinkler system shall enter into a contract with a contractor and the form of the contract shall be approved by a Sprinkler System Certifier (SSC).

1201.2

To check continued compliance with this Standard, a SSC may request permission from the owner to enter the protected premises and to check any or all parts of the system and such a request shall not be unreasonably denied.

If a SSC requires any valve, pump, alarm or other device to be manipulated as a part of the check, the owner shall arrange for his contractor to attend and to carry out such operations.

Appendix P provides guidelines for the routine inspection and maintenance of non-standard sprinkler systems.

1201.3

A written copy of all tests and maintenance shall be made in a form approved by a SSC. A copy of the record shall be retained at the control valves or other suitable location on the site. If the records are not kept at the control valves, an indelible sign shall be provided at the control valves stating where they are kept. A full report on each routine inspection shall be sent to both the owner and a SSC.

1201.4

To ensure that the sprinkler system can be expected to perform in accordance with its design criteria all gauge and instrument readings recorded during routine testing are to be compared to the reference information supplied as per 210, 607.4.8 and 607.7.1(j). Where the gauge and instrument readings are not in agreement with the reference information appropriate remedial action shall be taken to restore the performance of the sprinkler installation.

1202 ROUTINE TESTS AND MAINTENANCE

1202.1 Weekly

The following procedures shall be carried out at weekly intervals:

(a) Diesel engine driven pumps shall be exercised under full load for a period of at least 15 minutes and shall be checked for correct start, run and stop functions and that expected key performance indicators are being achieved, including engine speed, discharge and suction pressures and for battery, fuel, oil and water levels;

(b) Electric motor driven pumps which do not have the power supply to them continuously supervised by an approved alarm device (see 607.7.6), shall be exercised under full load for a period of at least 5 minutes and shall be checked for correct start, run and stop functions, delivery and suction pressures (as listed on the pressure Gauge Schedule).

NOTE – Minimum requirements for pump speed, discharge and suction pressures are provided in the Water Supply Gauge Schedule.

1202.2 Monthly

The following procedures shall be carried out at not longer than monthly intervals:

(a) The correct operation of every input into the fire brigade alarm signal generator, including pressure sensors and anti-interference alarms and the correct operation of the fire brigade alarm signal generating unit shall be checked. Where fitted, the interconnection between the sprinkler system and the evacuation system shall be tested to ensure that the evacuation alarms will sound on operation of the sprinkler system. It is not necessary to check that all sounders operate correctly, as regular testing of the fire alarm system will ensure the adequacy of the evacuation sounders (refer to NZS 4512);

(b) All chains, locks and straps within the sprinkler valve house and pump house shall be checked;

(c) The hydraulic gong shall be exercised and, if necessary, oiled;

(d) Every stop valve on the water supplies, other than street valves, shall be checked to ensure that it is open, correctly marked and secured;

(e) The control valves, and the area immediately around them in the valve house, shall be checked for free access and, if necessary, cleared. If free access cannot be achieved, the situation shall be reported to the building owner and noted in the report;

(f) All static pressure gauges listed on the pressure gauge schedule shall be checked against this schedule. If any pressures indicate a defective water supply, a flow test in accordance with 1202.3(d) shall be undertaken;

(g) Electric motor driven pumps which have their power supply supervised by an approved alarm device (see 607.7.6), shall be exercised under full load for a period of at least 5 minutes and shall be checked for correct start, run and stop functions, delivery and suction pressure (as listed on the pressure Gauge Schedule), and for correct operation of the monitoring device;

(h) Diesel engine driven pumps, in addition to the weekly test, shall be checked for battery acid density, battery age, external cleanness, belt tightness and cooling water filter state;

(i) Any tank water supply shall be checked and the level recorded. If the level is less than required, the building owner shall be notified and the report annotated to that effect;

(j) Where sprinkler heads are in a dirty atmosphere and are protected by covering with light paper bags, the bags shall be checked monthly, or more frequently if heavily contaminated.

NOTE – It is not intended that every subsidiary stop valve be exercised monthly. Sectional isolation valves are addressed in 1202.3.

1202.3 Quarterly

The following procedures shall be carried out at not longer than quarterly intervals:

(a) The installation pressure of each installation shall be dropped by means of the drain valve and the operating pressures of the fire brigade alarm and hydraulic gong checked and recorded. The correct operation of the hydraulic gong shall also be checked;

(b) All street and site fire main valves shall be visually inspected to ensure accessibility and, where safe to do so, manually operated to ensure that they are fully open;

NOTE – Where valves are located in main traffic lanes it may not be safe to manually operate them. In such cases the requirement to carry out a manual check to ensure that the valves are fully opened may be waived.

(c) The hose reel water supply shall be checked (if applicable);

NOTE – It is recommended that water supplies to all supplementary fire protection systems are inspected during this quarterly inspection. This includes any riser, hydrant, deluge and other fire protection systems installed in conjunction with the sprinkler system.

(d) Each town's main water supply shall be separately tested through the 50 mm drain valve (or substitute device) to determine whether there has been any deterioration compared with the water supply reference pressures displayed at the control valves. Such tests shall be carried out with any pumps isolated. If the recorded pressure is less than that noted in the pressure Gauge Schedule, a flow test in accordance with the following note shall be undertaken;

NOTE –

(1) Where the drain valve is used for this test, because of the comparatively low flow from a 50 mm orifice, a significant deterioration in the water supply may produce only a minor reduction in residual pressure. It is therefore essential to use accurate gauges and to read and record the gauges with great care.

(2) This test should be regarded as indicative. In the event of a reduction in pressure below the reference pressure:

  (i) The water supply should be regarded as being defective and the fact reported IMMEDIATELY to a SSC unless the defect can be remedied forthwith, and

  (ii) A full water supply test is to be carried out using the fire sprinkler inlet (or substitute device).

(e) Each subsidiary stop valve and its supervisory system shall be checked to ensure correct operation, and that the valve is open, correctly marked and secured;

(f) Flow switches and their associated panel indicators installed in buildings of more than six storeys or where flow switches are used for critical functions, shall be tested on a quarterly basis using the test facility described in 407.4;

NOTE – The use of flow switches to control an evacuation system, such as an EWIS system would be regarded as a critical function.

(g) A check shall be carried out of all subsidiary systems, including preaction systems, tail-end antifreeze systems, deluge systems and water mist systems. See Appendix P for guidance;

(h) A visual inspection shall be undertaken to ensure that any Toby box covering street isolation valves is accessible in an emergency;

(i) Where sprinkler heads are in dirty atmospheres and are protected by covering with approved light paper bags the bags shall be checked and replaced quarterly if heavily contaminated;

(j) Where sprinklers are located to protect commercial cooking extraction equipment sprinklers below filters shall be checked quarterly, and replaced if heavily contaminated.

1202.4 Yearly checks

The following procedures shall be carried out at the frequency specified:

(a) Every diesel engine forming part of a diesel engine driven pump unit shall be serviced by the engine manufacturer's agent every year, the oil changed, and a check made of the air filter, the coolant for corrosion, and the fuel for bacterial sludging.

Additionally, every second year, the service shall include changing the oil filters, fuel filters, belts and thermostats. This service shall be followed by a full load run of the pump unit for at least 2 hours;

(b) Check valves forming part of tail-end antifreeze installations and the density of the antifreeze solution shall be checked at least annually (see Appendix P);

(c) Flow switches, unless required to be tested quarterly in 1202.3(f), shall be tested annually;

(d) Backflow prevention devices forming part of the water supply system being supplied with potable water shall be tested annually according to the procedure specified in the New Zealand Building Code Clause G12;

NOTE – Automatic backflow preventors, and fire sprinkler systems are required to be tested in accordance with the procedures on the compliance schedule issued by the TA. The compliance schedule for automatic backflow prevention references the United States Environment Protection Agency Cross Connection Control Manual and AS 2845:Part 3.

(e) Any pump set flexible couplings that rely on elastomeric elements for transmission of drive shall be inspected for obvious wear and deterioration. If any evidence of wear or deterioration is obvious, the coupling's elastomeric element shall be replaced;

(f) Where sprinkler heads are in dirty atmospheres and are protected by covering with approved light paper bags the bags shall be replaced annually, or more frequently if heavily contaminated;

(g) Where multiple installations are served through a single fire sprinkler inlet (see figure 6.13), the check valves shall be exercised annually, to ensure that they are free and not seized shut;

(h) Antifreeze drops shall be drained and refilled with fresh antifreeze agent, or alternatively, replaced with dry barrel sprinklers;

(i) Where sprinklers are located to protect commercial cooking extraction equipment, sprinklers above filters shall be checked annually, and replaced if heavily contaminated.

1202.5 Biennial checks

The following procedures shall be carried out at the frequency specified:

(a) Each battery of every diesel engine driven pump set shall be routinely replaced every four years except that one of the batteries shall be initially replaced after two years so that, thereafter, one battery is replaced every two years.

In this context "battery" means a set of cells connected to a single charger;

(b) All surfaces of fire walls which provide separation between sprinklered and unsprinklered firecells or between sprinklered and unsprinklered buildings shall be inspected to confirm that the wall has not been perforated or its integrity impaired. Such inspections shall be made annually for non-masonry fire walls and at intervals not exceeding 2 years for masonry firewalls;

A1 (c) When fire hose reel systems are installed to meet with 208.2 their hydraulic performance shall be checked.

1202.6 Quadrennial checks

The following procedures shall be carried out at the frequency specified:

(a) The alarm valve, main stop valve, drain valve and water supply check valves shall be overhauled four-yearly. Soft seated water supply check valves shall have their elastomeric components replaced. Metal-seated check valves shall be physically inspected or tested, and necessary remedial action shall be undertaken to ensure that they are in a serviceable condition. All small bore strainers, including those on Type Y alarm bypass trims shall be inspected and cleaned as necessary;

(b) Every water supply tank shall be visually checked four-yearly for cleanness and, if necessary, emptied and cleaned out;

(c) All pilot operated control valves, (including pressure reducing valves, pressure relief valves, pressure sustaining valves, tank level control valves, and the like) shall be disassembled, have elastomeric components replaced, cleaned, reassembled and be recommissioned;

(d) Diaphragm style valves used on fire sprinkler inlets and as part of pump or diesel engine cooling circuits shall have their elastomeric components replaced;

(e) Pumpset flexible drive couplings, which rely on the integrity of the elastomeric element shall have the element replaced.

NOTE – If physically possible, it would be preferable to replace the pump coupling with a coupling complying with 607.1.4(e). This approach would be expected to reduce the longer term maintenance costs for the sprinkler system.

1202.7 Non-standard sprinkler systems

In addition to the tests already specified in the preceding clauses, a SSC may specify such other tests as may be necessary for non-standard types of systems. See Appendix P for further information.

1202.8

Listed systems installed for the protection of commercial cooking extraction systems in accordance with 511.10.1 shall be routinely tested and maintained in accordance with their manufacturer's instructions, and any special instructions included with their listing criteria. These shall be inspected every six months.

1203 ROUTINE INSPECTIONS

1203.1

To operate effectively sprinkler systems must comply with this Standard in all respects at all times. To ensure that building alterations; changes in occupancy, processes or storage; or progressive deterioration of sprinkler system components do not prejudice the system a comprehensive inspection shall be carried out biennially at intervals not exceeding 28 months.

Such inspections shall be carried out by a contractor who has been independently accredited by an internationally recognised accreditation body to AS/NZS ISO/IEC 17020 as a Type A inspection body to inspect fire sprinkler systems for compliance with NZS 4541. See Appendix U, figure U2 for a compliance flowchart.

1203.2

The routine inspection shall include checks on the following matters with respect to compliance with this Standard:

(a) The operation, flow and pressure characteristics of each water supply with respect to the performance at the time of initial installation and the design flow and pressure at the time of inspection;

NOTE – Comparison with original characteristics at the time of installation will not necessarily indicate the need for remedial action, but could forecast the need for future remedial work.

(b) The operation of all pumps, tanks and tank filling, and any equipment associated with the water supplies;

(c) The operation, labelling and securing of all valves and controls and any other equipment that forms part of the sprinkler system, including all supervisory signalling and indicating devices;

(d) The accuracy within ± 4 % of all pressure gauges at normal supply pressure when checked against a test gauge certified to Part 2 of BS 1780;

(e) The currency of the block plan, adequacy of signage, and any required operating and maintenance instructions;

(f) Confirmation that all the routine tests and maintenance items due, as identified in Part 12 of this Standard, have been completed;

(g) The accessibility, functionality and labelling of the fire sprinkler inlet;

(h) The adequacy of sprinkler spacing and location throughout the protected area;

(i) The adequacy of the design density for the storage heights and categories and process risks present at the time of inspection;

(j) The adequacy of in-rack protection or in-rack bulkheads with respect to racking layouts present at the time of inspection;

(k) The adequacy of clear space below sprinkler heads;

(l) The adequacy of all storage height signs;

(m) The suitability and condition of installed sprinkler heads, and adequacy of visible pipework and its support structure;

(n) The adequacy of all fire rated partitions required in accessible concealed spaces, from which sprinkler protection has been omitted;

(o) The separation between protected and unprotected areas and the presence of, or separation for, exposure hazards;

(p) The density of antifreeze installations and the adequacy of separation barriers.

1203.3

The report shall indicate the items inspected and the results of all tests and additionally shall specifically provide the following information:

(a) The method of separation between protected and unprotected areas;

(b) The required design density and area of operation for each area of the building and the height of the highest sprinkler in each area;

(c) The required design flows and design pressures at the time of the inspection;

(d) An hydraulic sketch of each water supply as tested, with the design flows and pressures marked;

(e) A list of all matters that require remedy in order to maintain compliance with this Standard.

1203.4

When any deficiencies identified in the list described in 1203.3(e) are remedied, or if no deficiencies are noted, a SSC shall issue a certificate of compliance as prescribed in Appendix U. Notwithstanding this, if the deficiencies are significant, or if 12 months have passed between the inspection and rectification of the deficiencies, a SSC may require that a new inspection be carried out before such a certificate is issued.

1204 TWELVE-YEARLY INSPECTIONS

Water supply storage tanks shall be drained at twelve-yearly intervals, and the tank, any lining, and internal sprinkler components, such as anti-vortex plates and strainers, inspected.

1205 TESTING OF SPRINKLERS

NOTE – Appendix Q provides some guidance to the requirements for testing sprinklers.

1205.1

Where sprinklers have been in service for 50 years, or 20 years for quick response sprinklers, or 10 years for dry barrel sprinklers they shall be either:

(a) Replaced; or

(b) Representative samples from one or more sample areas shall be submitted to a recognised testing laboratory acceptable to a SSC for field service testing. Testing shall be repeated at 10-year intervals.

NOTE – Dry barrel sprinklers are often called dry drops in New Zealand. The term dry barrel sprinkler includes dry sprinklers designed for all orientations, including pendent, upright and sidewall orientations.

1205.2

Representative samples of solder-type sprinklers with a temperature classification of 163 °C or greater that are exposed to semi-continuous to continuous maximum allowable ambient temperature conditions shall be tested at 5-year intervals.

1205.3

Sprinklers manufactured prior to 1920 shall be replaced.

1205.4

A representative sample of sprinklers shall consist of a minimum of not less than 10 sprinklers or 1 % of the number of sprinklers in an individual sample area, whichever is greater.

1205.5

Where one sprinkler within a representative sample fails to meet the test requirement, all sprinklers represented by that sample shall be replaced.

1206 WATER SUPPLY STRAINERS

Following any significant flow through a water supply strainer, the strainer shall be internally inspected and cleaned. Significant flows are those that have a potential to block a strainer. This would include a full flow test, any sprinkler operation where a significant number of sprinklers operate, or a flow where experience on the site, or in the general area, indicates that the strainer may be partially blocked.

APPENDIX A – SPRINKLER SYSTEM STORAGE DECLARATION

(Informative)

A1 EXPLANATORY NOTE

The declaration is the design basis of a sprinkler system. It is most important to the building owner, the TA, the sprinkler contractor and the insurer that the materials and their packing, the storage system and the height of the storage are accurately and completely described on this declaration.

This declaration forms the basis of subsequent New Zealand Building Code Compliance, Sprinkler System Certifier (SSC) certification of the sprinkler system and insurance of the building and contents.

Sprinkler systems are specifically designed for the fire load declaration based on height of storage, category of goods and storage configuration. Incorrect information on this declaration could result in a fire overwhelming the sprinkler system.

A representative schedule of commodities is provided in Appendix B. The category of any material is subject to final approval of a SSC when accepting the design parameters. If in doubt consult a SSC.

DECLARATION OF STORAGE INTENTIONS

(1) This form is to be completed and signed by the owner of the building, or where applicable and with the owner's agreement, by the architect or consulting engineer engaged on the building project.
(2) Please read the EXPLANATORY NOTES in A1 of NZS 4541 before completing the form.

I,..of...

(Company)

being/being the authorised representative of, the..

(Owner, Architect, Consulting Engineer)

of the premises to be protected by an automatic sprinkler system at the following street
address:..
building known as...
hereby declare, that having read the list and classifications of various combustibles and explanatory note in A1. The following sets out the owner's intentions on the storage of combustible materials in these premises and may be taken as a basis for the design of the sprinkler system.

I further declare that it is my intention/instructions that:

(a) The height of storage will not be increased beyond that declared;
(b) The combustibles stored will not be of a higher category than that declared;
(c) That storage limitation signs will be displayed as required;
(d) Storage will remain at least 0.5 m below ELH/OH sprinkler, and at least 0.9 m below EHH sprinklers.

The sprinkler contractor may complete the following 5 sections on behalf of the Building Owner (but may not sign the form).

1 ELH occupancies – Storage rooms are/are not present (circle) – See 704.
2. Ordinary hazard – Describe occupancy (table 2.1)...

Storage (if present) – See 203.3.4	Description of typical goods
Category 1...............................height	....
Category 2...............................height	....
Category 3...............................height	....
Category 4...............................height	....
Category 5...............................height	....
Category 6...............................height	....

3. Ordinary hazard 3S Risk (table 2.1) or Extra Hazard Process Risk (table 9.7) Goods/Process ....
....
4. Extra high hazard/CMSA/SMS/special commodity (circle) Other ....

Description of Typical Goods	Rack//Solid Pile/Shelf/Bin Box	Category of Goods	Maximum Storage Height
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

NOTE – Please ensure locations of hazard category and shelves/racking are shown on block plan.

5. Deluge System/Pre-action System/Antifreeze System/Dry System (circle if present)
Description of risk being protected...

Building Owner/Agent

Name:............................. Company:............................. Signature:............................. Date:..................
(Please Print) (Please Print)

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Figure A1 – Declaration of storage intentions

Table A1 – Representative list of material categories
(See Appendix B for further detail)

Category 1	**Category 2**
Alcoholic beverages (up to 20 % alcohol) in metal, glass, or ceramic containers – cartoned or uncartoned. Appliances (stoves, refrigerators) with no appreciable plastics – unpackaged. Batteries – automobile (filled). Batteries – dry cells, excluding lithium or exotic metals – in single walled cartons. Bottles, jars – glass empty or filled with noncombustible liquid or powder – in single walled cartons. Bottles, jars – plastic; <19 litres filled with noncombustible liquid in single walled cartons. Bottles, jars – PET plastic filled with noncombustible liquids. Coffee – canned in single walled cartons. Fertilisers – phosphates – bagged or un-bagged. Fresh fruit and vegetables – on nonplastic trays or containers. Liquids or semi-liquids – noncombustible – in plastic containers in single walled cartons. Meat and food products – canned – in single walled cartons. A1 Meat and food products – frozen – in nonwaxed, nonplastic packing. Metal desks and furniture – with plastic tops and trim. Milk and non-alcoholic beverages – in waxed, nonwaxed, paper containers and plastic containers. Motors – electric – in single walled cartons or uncartoned. Nuts – canned – in single walled cartons. Paints, water based latex – in cans – in single walled cartons. Syrup and liquid sugar products – in metal drums. Wire – bare on metal spools – on wooden skids.	Alcoholic beverages (up to 20 % alcohol) in wooden containers. Appliances (stoves, refrigerators) with no appreciable plastics – single walled cartons. Baked goods – frozen biscuits, cakes, pies – cartoned. Batteries – dry cells, excluding lithium or exotic metals – blister packs in cartons. Books, magazines – solid bundles on wooden pallets. Bottles, jars – PET plastic filled with noncombustible powders. Boxes, crates – empty – wooden, solid walls. Fertilisers – nitrates – bagged. Leather hides – animal skins – baled. Light fixtures and electrical appliances – nonplastic – cartoned or uncartoned. Liquids or semi-liquids – noncombustible – in plastic containers with 6.4 mm or less wall thickness and larger than 19 litres. Meat and food products – frozen – waxed paper containers – cartoned, boxed or barrelled. Pharmaceuticals – pills and powders – in glass bottles – cartoned. Powders (ordinary combustible – free flowing) flour, sugar, etc. in paper bags. Syrup and liquid sugar products – wooden or plastic barrels. Wire – bare or insulated – spooled wooden skids.
Category 3	**Category 3** (continued)
Aerosols with 25 % or less flammable product (Level 1) Baked goods – bread, biscuits, cakes, pies – cartoned. Beans, pulses, grains, nuts – packaged – cartons. Butter, cheese and finished dairy products – cartoned or uncartoned. Carton flats – corrugated cardboard. Cereals – cartoned. Cloth – natural fibre – cartoned or uncartoned. Clothing – folded – cartoned. Confectionery and food products – cartoned. Cotton based hygiene products – cartoned. Cotton, linen – folded or rolled – cartoned or uncartoned. Dried foods – packaged or cartoned. Film – photographic – in metal cartridges – in plastic cans, boxed. Fresh fruit and vegetables – on plastic trays or containers. Frozen foods (fruit and vegetables) – no packaging. Furniture – wood, metal based with no plastic covering or foam cushions. Margarine – up to 50 % oil – paper or plastic containers. Mattresses – stand box spring – no packaging. Meat and food products – frozen – plastic trays or containers. Paper – medium or heavyweight rolled – in racks or on side. Paper – products – books, magazines, stationery – cartoned or uncartoned.	Paper products – newspapers, cardboard games – cartoned or uncartoned tissue products. Paper in sheets – in cardboard boxes. Paper in sheets – stationery – bagged in polythene. PVC (polyvinylchloride) – flexible, rigid, bagged resins – cartoned or uncartoned. Synthetic – fabric 50/50 blend or less – unpackaged – thread yarn 50/50 blend or less – on wood or paper spools – textiles (except rayon and nylon) – 50/50 blend or less – cartoned or uncartoned. Tobacco products – cigarettes or cigars – in paperboard cartons. Wood products – toothpicks, pegs, hangers – in cartons. Wood products – finished goods – doors, windows, furniture – cartoned or uncartoned.

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Category 4	**Category 5 – Cartoned unexpanded and expanded plastics**
Ammunition – gunpowder based – cartoned. Baled fibres – stored in racks. Bottles, jars – PET plastic – cartoned. Cartons – corrugated cardboard – partially assembled. Cloth – synthetics – cartoned or uncartoned. Fibreglass insulation – paper backed rolls – bagged or unbagged. Film – photographic – in plastic cassettes – cardboard boxes. Foam covered finished goods – skis, surfboards etc. Furniture – wood based with plastic coverings. Hygiene products – with plastic and nonwoven fabric – in cartons. Light fixtures and electrical appliances – metal and plastic – cartoned. Liquor 100 % proof or less – glass bottles 3.87 litres or less – cartoned. A1 Nail polish – glass bottles 30 ml – 60 ml – cartoned. Paints, oil based – in cans, cartoned. Paper, lightweight – rolled, in racks. Paper products – waxed – cartoned. Pharmaceuticals – pills, powders, in plastic bottles – cartoned. PVA (polyvinylalcohol) – resins – bagged. Rags, synthetic fibres – baled. Rubber – natural – blocks or cartoned. Textiles – synthetics – on wood or paper spools. Vinyl floor coverings – tiles – cartoned. Waste paper – baled – stored in racks. Wire – on plastic spools – cardboard boxed or unboxed	Batteries – truck or larger. Bottles, jars – plastic, empty or filled with noncombustible product – crated or uncrated. Candles – treat as expanded plastic – cartoned. Carpet – tiles – cartoned. Foamed plastic and foam rubber goods – cartoned. Furniture – wood with foam plastic cushioning. Hygiene products – with plastics and nonwoven fabric – uncartoned, plastic wrapped. Lighters, butane – plastic – blister packed. Margarine – 51 % - 80 % oil – all packaging. Matches – boxes or packets – wood cartoned. Milk containers – empty – in plastic crates. Nail polish – plastic bottles 30 ml – 60 ml – cartoned. Paper products – tissue products – uncartoned and plastic wrapped. Plastic containers – empty or filled – cartoned or uncartoned. Polyurethane – foam – cartoned. Rubber – synthetic. Stuffed toys – foam or synthetic filled – cartoned or uncartoned. Textiles – sythetics – baled, cartoned or uncartoned. Vinyl floor covering – rolled. Vinyl coated fabric – rolled. Wax, paraffin – blocks – cartoned. Wax-coated paper – cups, plates – loose in cartons. Wire – bulk storage of empty plastic spools.
Category 6 – Uncartoned expanded plastics	**Special Commodities**
Expanded styrene products – exposed (uncovered). Polyurethane products – exposed (uncovered).	Aerosols – Level 2 & 3. Baled fibres and waste paper – not racked. Carpet storage – rolls. Distilled sprits storage – barrels. Hanging garments storage. Idle pallet storage. Roll paper storage. Rubber tyre storage.

NOTE –

(1) This form may be used to obtain approval from the insurance carrier.

(2) Where Category 1 – 4 goods are stored on plastic pallets, the category should be increased by one level. A change of category is not necessary where the goods are recorded as plastic

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APPENDIX B – MATERIAL CLASSIFICATIONS

(Informative)

B1 COMMODITY CLASS TABLES

Commodity categories are in accordance with table B1 (Alphabetical Listing) and table B2 (Category Listing).

Table B1 – Commodity and category examples – Alphabetical listing

Commodity description			**Category reference**
Basic commodity	**Description**	**Packaging**	
Aerosol	Levels 2 & 3	Cartoned	Special
Alcoholic beverages	Up to 20 % alcohol	In metal, glass or ceramic containers – cartoned (single walled) or uncartoned	1
		in wood containers	2
Ammunition	Gunpowders	Cartoned	4
Appliances	E.g. stoves, refrigerators – no appreciable plastic exterior or exterior trim	Cartoned	2
		Not packaged	1
Baked goods	Bread, biscuits, cakes, pies	Cartoned	3
	Frozen biscuits, cakes, pies	Cartoned	2
Baled fibres	Solid piles	None	Special
	Stored in racks	None	4
Batteries	Automobile, filled	None	1
Batteries	Dry cells, non-lithium or similar exotic metals	Blister pack in cartons	2
		Packaged in cartons (single walled)	1
	Truck or larger-empty or filled	None	5
Beans, pulses, grains, nuts (dried)	Foodstuffs	Packaged, cartoned	3
Books, magazines	Solid array on pallet	None	2
Bottles, jars	Glass – empty	Cartoned (single walled)	1
	Glass – filled with noncombustible liquids	Cartoned (single walled)	1
		Cartoned (single walled)	1
	Plastic – filled with noncombustible liquids	Open or solid plastic crates	5
	Plastic – filled with noncombustible powders	Open plastic crates	5
		Solid plastic crates	5
	Plastic (other than PET), any size – empty	None	5
	Plastic PET (polyethylene terephthalate) – empty	Cartoned	4
	Plastic PET (polyethylene terephthalate) – filled with noncombustible powders	None	2
	Plastic, greater than 3.8 litre – filled with noncombustible powders	Cartoned or uncartoned	5
	Plastic, less than 19 litres – filled with noncombustible liquids	Cartoned (single walled)	1
	Plastic, PET – filled with non-combustible liquids	None	1
Boxes, crates	Empty, wood, solid walls	None	2
Butter, cooking oils	Foodstuffs	Packaged – cartoned	3
Candles	Treat as expanded plastic	Packaged – cartoned	5
Cans	Metal – empty	None	1

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Commodity description			**Category reference**
Basic commodity	**Description**	**Packaging**	
Carpet	Rolls	None	Special
	Tiles	Cartoned	5
Cartons	Corrugated cardboard – flat	None	3
	Corrugated cardboard – partially assembled	None	4
	Wax coated – single walled	None	5
Cereals	Foodstuffs	Cartoned	3
Cheese and finished dairy products	Foodstuffs	Cartoned or uncartoned	3
Cloth	Natural fibre – viscose	Cartoned or uncartoned	3
	Synthetics	Cartoned or uncartoned	4
Clothing (excluding multilevel hanging garments)	Folded	Cartoned or uncartoned	3
Coffee	Canned	Cartoned (single walled)	1
Confectionery and food products		Cartoned	3
Cotton based hygiene products	Personal care	Cartoned	3
Cotton, linen	Rolled or folded	Cartoned or uncartoned	3
Distilled spirits	20 % to 40 % by vol.	Glass and PET bottles	Special
	Up to 75 % vol.	Wood or metal barrels	Special
Dried foods	Foodstuffs	Packaged – cartoned	3
Expanded styrene products, exposed (uncovered)	Building products	None	6
	Food and beverage containers	None	6
	Insulation sheets	None	6
	Packaging mouldings	None	6
	Produce boxes	None	6
	Rolled sheets	None	6
Fertilisers	Nitrates	Bagged	2
Fertilisers	Phosphates	Bagged or unbagged	1
Fibreglass insulation, paper backed rolls	Building products	Bagged or unbagged	4
File cabinets and metal furniture	Office furniture	Cartoned (single walled)	1
Film	Photographic – 35 mm in metal film cartridges	In polyethylene cans in cardboard boxes	3
	Photographic – rolls	In polycarbonate plastic cassettes, in cardboard boxes	4
	Photographic or motion picture	In metal cans in cardboard boxes	2
Foam core based finished goods	E.g. skis, surfboards	None	4
Foamed plastic and rubber goods	Household goods	In cartons	5
Fresh foods (fruits and vegetables)	Foodstuffs	Packaged on nonplastic trays or containers	1
		Packaged on plastic trays or containers	3
Frozen foods	Foodstuffs	None	3
		Waxed-paper containers – cartoned, boxed or barreled	2

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Commodity description			Category reference
Basic commodity	Description	Packaging	
Furniture	Wood based with plastic coverings	None	4
	Wood, metal based, no plastic coverings or foam plastic cushioning	None	3
	Wood, with foam plastic cushioning	None	5
Hanging garments	Clothing	None	Special
Hygiene products	Disposable with plastics and nonwoven fabric	In cartons	4
		Uncartoned, plastic wrapped	5
Leather hides	Animal skins	Baled	2
Light fixtures & electrical appliances	Metal and plastic	Cartoned	4
	Nonplastic	Cartoned or uncartoned	2
Lighters, butane	Plastic	Blister packed	5
Liquids or semi-liquids, non-combustible, in plastic containers less than 19 litre capacity	Plastic containers less than 19 litre capacity	Cartoned (single walled) or uncartoned	1
Liquor 100 % proof or less, 3.8 litre or less, cartoned glass bottles (palletised)	Palletised	Cartoned	4
Marble	E.g. artificial sinks, countertops	Cartoned – crated	2
Margarine	Greater than 50 % up to 80 % oil	In any packaging	5
	Up to 50 % oil	In paper or plastic containers	3
Matches	Boxes or packets	Packaged – wood cartoned	5
Mattresses	Foam, in finished form	None or plastic wrapped	6
	Standard box spring	None	3
Meat and food products	Foodstuffs	Canned – cartoned (single walled)	1
	Frozen	Nonwaxed, nonplastic packaging	1
		Plastic trays or containers	3
		Waxed-paper containers	2
Metal desks and furniture, with plastic tops and trim	Furniture	None	1
Metal goods	Various	Cartoned	1
Milk and non-alcoholic beverages	Foodstuffs	Nonwaxed paper containers	1
		Plastic containers	1
		Waxed paper containers	1
Milk containers	Empty	Plastic crates	5
Motors	Electric	None or cartons (single walled)	1
Nail polish	Glass bottles – 30 ml to 60 ml	Cartoned	4
	Plastic bottles – 30 ml to 60 ml	Cartoned	5
Natural fibre clothing or textile products	Clothing	Cartoned or uncartoned	3
Nuts	Foodstuffs	Canned – cartoned (single walled)	1
Paints	Oil based, enamels	In cans – cartoned	4
	Water based, latex	In cans – cartoned (single walled)	1
Pallets	Idle	None	Special

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Commodity description			Category reference
Basic commodity	Description	Packaging	
Paper	Lightweight, rolled – in racks	None	4
	Medium or heavyweight, rolled – in racks or on side	None	3
Paper products	Books, magazines, stationery, plastic-coated paper food containers	Cartoned or uncartoned	3
	Newspapers, cardboard games, cartoned tissue products	Cartoned	3
Paper products (continued)	Tissue products including toilet rolls and paper towels	Uncartoned and plastic wrapped	5
	Waxed	Packaged in cartons	4
Paper, in sheets	Stationery	In cardboard boxes	3
		Bagged in polyethylene	3
Pharmaceuticals	Pills, powders	In glass bottles – cartoned	2
		In plastic bottles – cartoned	4
Plastic containers	Combustible or non-combustible solids in plastic containers and empty plastic containers	None or cartoned	5
	Liquids or semi-liquids (non-combustible) in plastic containers with nominal wall thickness of 6.4 mm or less and larger than 19 litre capacity	None or cartoned	2
	Noncombustible liquids or semi-liquids (such as sauces) in plastic containers with nominal wall thickness greater than 6.4 mm and larger than 8.9 litre capacity	None or cartoned	5
Polyurethane	Foam	Cartoned	5
Polyurethane products, exposed (uncovered)	Architectural mouldings	None	6
	Cushioning	None	6
	Hose, seals and extruded products	None	6
	Rolled insulation	None	6
	Sheet lining material	None	6
	Wheels, gaskets and other component mouldings	None	6
Powders (ordinary combustibles – free flowing)	E.g. flour, sugar	In paper bags	2
PVA (polyvinyl alcohol) resins		Bagged	4
PVC (polyvinyl chloride)	Flexible (e.g. cable jackets, plasticized sheets)	None or cartoned	3
	Resins	Bagged	3
	Rigid (e.g. pipe, pipe fittings)	None	3
Rags, synthetic fibres	Baled	None	4
Roll paper	Light, med and heavyweight	Wrapped or banded	Special
Rubber	Natural	Blocks or in cartons	4
	Synthetic		5
Stuffed toys	Foam or synthetic fill	None or cartoned	5
Synthetics	Fabric – 50/50 blend or less	None	3
	Thread, yarn – 50/50 blend or less	On wood or paper spools	3

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Commodity description			Category reference
Basic commodity	**Description**	**Packaging**	
Syrup and liquid sugar products	Foodstuffs	Barrelled – wood and plastic	2
	Foodstuffs	Drummed – metal containers	1
Textiles	Synthetics, except rayon and nylon – 50/50 blend or less	Baled fibre	5
	Synthetics, except rayon and nylon – greater than 50/50 blend	Cartoned or uncartoned	3
	Synthetics, except rayon and nylon, thread, yarn – 50/50 blend or less	Cartoned or uncartoned	4
	Synthetics, except rayon and nylon, thread, yarn – greater than 50/50 blend	Cartoned or uncartoned	5
	Synthetics, except rayon and nylon, thread, yarn – greater than 50/50 blend	On wood or paper spools	4
	Synthetics, rayon and nylon, fabrics, thread and yarn	On wood or paper spools	4
		On plastic spools	5
Tobacco products	Cigarettes or cigars	In paperboard cartons	3
Tyre storage	Rubber	None	Special
Vinyl floor coverings	Rolled	None	5
	Tiles	Cartoned	4
Vinyl-coated fabric	Rolled	None	5
Waste paper	Baled	None	4
Wax, paraffin	Blocks	Cartoned	5
Wax-coated paper	Cups, plates	Boxed or packaged inside cartons (emphasis is on packaging)	4
	Cups, plates	Loose inside large cartons	5
Wire	Bare wire on metal spools	On wood skids	1
	Bare wire on metal, wood, or cardboard spools	In cardboard boxes – on wood skids	2
	Bare wire on plastic spools	In cardboard boxes – on wood skids	4
	Bare wire on wood or cardboard spools	On wood skids	2
	Bulk storage of empty plastic spools	None	5
	Insulated (PVC) cable on large wood or metal spools	On wood skids	2
	Single or multiple layer PVC covered wire on plastic spools	In cardboard boxes – on wood skids	4
	Single or multiple-layer PVC-covered wire on metal spools	On wood skids	2
	Single, multiple, or power cables (PVC) on large plastic spools	None	4
Wood products	Solid piles, lumber, plywood, particle board, presswood (flush ends and sides)	None	2
	Spools, empty	None	3
	Toothpicks, clothes pegs, hangers	In cartons	3
	Wood based finished goods (e.g. doors, windows, wood cabinets, and furniture)	None or cartoned	3

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Table B2 – Commodity and category examples – Listed by category

Category reference	Commodity description		
	Basic commodity	Description	Packaging
1	Alcoholic beverages	Up to 20 % alcohol	In metal, glass or ceramic containers – cartoned (single walled) or uncartoned
1	Appliances	E.g. stoves, refrigerators – no appreciable plastic exterior or exterior trim	Not packaged
1	Batteries	Automobile, filled	None
		Dry cells, non-lithium or similar exotic metals	Packaged in cartons (single walled)
1	Bottles, jars	Glass – empty	Cartoned (single walled)
		Glass – filled with noncombustible liquids	Cartoned (single walled)
		Glass – filled with noncombustible powders	Cartoned (single walled)
		Plastic, less than 19 litres – filled with noncombustible liquids	Cartoned (single walled)
		Plastic, PET – filled with non-combustible liquids	None
1	Cans	Metal – empty	None
1	Coffee	Canned	Cartoned (single walled)
1	Fertilisers	Phosphates	Bagged or unbagged
1	File cabinets and metal furniture	Office furniture	Cartoned (single walled)
1	Fresh foods (fruits and vegetables)	Foodstuffs	Packaged on nonplastic trays or containers
1	Liquids or semi-liquids, noncombustible, in plastic containers less than 19 litre capacity	Plastic containers less than 19 litre capacity	Cartoned (single walled) or uncartoned
1	Meat and food products	Foodstuffs	Canned – cartoned (single walled)
		Frozen	Nonwaxed, nonplastic packaging
1	Metal desks and furniture, with plastic tops and trim	Furniture	None
1	Metal goods	Various	Cartoned
1	Milk and non-alcoholic beverages	Foodstuffs	Nonwaxed paper containers
		Foodstuffs	Plastic containers
		Foodstuffs	Waxed paper containers
1	Motors	Electric	None or cartons (single walled)
1	Nuts	Foodstuffs	Canned – cartoned (single walled)
1	Paints	Water based, latex	In cans – cartoned (single walled)
1	Syrup and liquid sugar products	Foodstuffs	Drummed – metal containers
1	Wire	Bare wire on metal spools	On wood skids
2	Alcoholic beverages	Up to 20 % alcohol	In wood containers
2	Appliances	E.g. stoves, refrigerators – no appreciable plastic exterior or exterior trim	Cartoned
2	Baked goods	Frozen biscuits, cakes, pies	Cartoned

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A1

Category reference	Commodity description		
	Basic commodity	Description	Packaging
2	Batteries	Dry cells, non-lithium or similar exotic metals	Blister pack in cartons
2	Books, magazines	Solid array on pallet	None
2	Bottles, jars	Plastic PET (polyethylene terephthalate) – filled with noncombustible powders	None
2	Boxes, crates	Empty, wood, solid walls	None
2	Fertilisers	Nitrates	Bagged
2	Film	Photographic or motion picture	In metal cans in cardboard boxes
2	Frozen foods	Foodstuffs	Waxed-paper containers – cartoned, boxed or barrelled
2	Leather hides	Animal skins	Baled
2	Light fixtures & electrical appliances	Nonplastic	Cartoned or uncartoned
2	Marble	E.g. artificial sinks, countertops	Cartoned – crated
2	Meat and food products	Frozen	Waxed-paper containers
2	Pharmaceuticals	Pills, powders	In glass bottles – cartoned
2	Plastic containers	Liquids or semi-liquids (non-combustible) in plastic containers with nominal wall thickness of 6.4 mm or less and larger than 19 litre capacity	None or cartoned
2	Powders (ordinary combustibles – free flowing)	E.g. flour, sugar	In paper bags
2	Syrup and liquid sugar products	Foodstuffs	Barrelled – wood and plastic
2	Wire	Bare wire on metal, wood, or cardboard spools	In cardboard boxes – on wood skids
		Bare wire on wood or cardboard spools	On wood skids
		Insulated (PVC) cable on large wood or metal spools	On wood skids
		Single or multiple-layer PVC-covered wire on metal spools	On wood skids
2	Wood products	Solid piles, lumber, plywood, particle board, presswood (flush ends and sides)	None
3	Baked goods	Bread, biscuits, cakes, pies	Cartoned
3	Beans, pulses, grains nuts (dried)	Foodstuffs	Packaged, cartoned
3	Butter, cooking oils	Foodstuffs	Packaged – cartoned
3	Cartons	Corrugated cardboard – flat	None
3	Cereals	Foodstuffs	Cartoned
3	Cheese and finished dairy products	Foodstuffs	Cartoned or uncartoned
3	Cloth	Natural fibre – viscose	Cartoned or uncartoned
3	Clothing (excluding multilevel hanging garments)	Folded	Cartoned or uncartoned
3	Confectionery and food products		Cartoned
3	Cotton based hygiene products	Personal care	Cartoned
3	Cotton, linen	Rolled or folded	Cartoned or uncartoned
3	Dried foods	Foodstuffs	Packaged – cartoned

Category reference	Commodity description		
	Basic commodity	Description	Packaging
3	Film	Photographic – 35 mm in metal film cartridges	In polyethylene cans in cardboard boxes
3	Fresh foods (fruits and vegetables)	Foodstuffs	Packaged on plastic trays or containers
3	Frozen foods	Foodstuffs	None
3	Furniture	Wood, metal based, no plastic coverings or foam plastic cushioning	None
3	Margarine	Up to 50 % oil	In paper or plastic containers
3	Mattresses	Standard box spring	None
3	Meat and food products	Frozen	Plastic trays or containers
3	Natural fibre clothing or textile products	Clothing	Cartoned or uncartoned
3	Paper	Medium or heavyweight, rolled – in racks or on side	None
3	Paper products	Books, magazines, stationery, plastic-coated paper food containers	Cartoned or uncartoned
		Newspapers, cardboard games, cartoned tissue products	Cartoned
3	Paper, in sheets		In cardboard boxes
		Stationery	Bagged in polyethylene
3	PVC (polyvinyl chloride)	Flexible (e.g. cable jackets, plasticised sheets)	None or cartoned
		Resins	Bagged
		Rigid (e.g. pipe, pipe fittings)	None
3	Synthetics	Fabric – 50/50 blend or less	None
		Thread, yarn – 50/50 blend or less	On wood or paper spools
3	Textiles	Synthetics, except rayon and nylon – greater than 50/50 blend	Cartoned or uncartoned
3	Tobacco products	Cigarettes or cigars	In paperboard cartons
3	Wood products	Spools, empty	None
		Toothpicks, clothespins (pegs), hangers	In cartons
		Wood based finished goods (e.g. doors, windows, wood cabinets, and furniture)	None or cartoned
4	Ammunition	Gunpowders	Cartoned
4	Baled fibres	Stored in racks	None
4	Bottles, jars	Plastic PET (polyethylene terephthalate) – empty	Cartoned
4	Cartons	Corrugated cardboard – partially assembled	None
4	Cloth	Synthetics	Cartoned or uncartoned
4	Fibreglass insulation, paper backed rolls	Building products	Bagged or unbagged
4	Film	Photographic – rolls	In polycarbonate plastic cassettes, in cardboard boxes
4	Foam core based finished goods	E.g. skis, surfboards	None
4	Furniture	Wood based with plastic coverings	None
4	Hygiene products	Disposable with plastics and nonwoven fabric	In cartons

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Category reference	Commodity description		
	Basic commodity	**Description**	**Packaging**
4	Light fixtures & electrical appliances	Metal and plastic	Cartoned
4	Liquor 100 % proof or less, 3.8 litre or less, cartoned glass bottles (palletised)	Palletised	Cartoned
4	Nail polish	Glass bottles – 30 ml to 60 ml	Cartoned
4	Paints	Oil based, enamels	In cans – cartoned
4	Paper	Lightweight, rolled – in racks	None
4	Paper products	Waxed	Packaged in cartons
4	Pharmaceuticals	Pills, powders	In plastic bottles – cartoned
4	PVA (polyvinyl alcohol) resins		Bagged
4	Rags, synthetic fibres	Baled	None
4	Rubber	Natural	Blocks or in cartons
4	Textiles	Synthetics, except rayon and nylon, thread, yarn – 50/50 blend or less	Cartoned or uncartoned
		Synthetics, except rayon and nylon, thread, yarn – greater than 50/50 blend	On wood or paper spools
		Synthetics, rayon and nylon, fabrics, thread and yarn	On wood or paper spools
4	Vinyl floor coverings	Tiles	Cartoned
4	Waste paper	Baled	None
4	Wax-coated paper	Cups, plates	Boxed or packaged inside cartons (emphasis is on packaging)
4	Wire	Bare wire on plastic spools	In cardboard boxes – on wood skids
		Single or multiple layer PVC covered wire on plastic spools	In cardboard boxes – on wood skids
		Single, multiple, or power cables (PVC) on large plastic spools	None
5	Batteries	Truck or larger – empty or filled	None
5	Bottles, jars	Plastic – filled with non-combustible liquids	Open or solid plastic crates
		Plastic – filled with non-combustible powders	Open plastic crates
		Plastic – filled with non-combustible powders	Solid plastic crates
		Plastic (other than PET), any size – empty	None
		Plastic, greater than 3.8 litre – filled with noncombustible powders	Cartoned or uncartoned
5	Candles	Treat as expanded plastic	Packaged – cartoned
5	Carpet	Tiles	Cartoned
5	Cartons	Wax coated – single walled	None
5	Foamed plastic and rubber goods	Household goods	In cartons
5	Furniture	Wood, with foam plastic cushioning	None
5	Hygiene products	Disposable with plastics and nonwoven fabric	Uncartoned, plastic wrapped
5	Lighters, butane	Plastic	Blister packed

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Category reference	Commodity description		
	Basic commodity	Description	Packaging
5	Margarine	Greater than 50 % up to 80 % oil	In any packaging
5	Matches	Boxes or packets	Packaged – wood cartoned
5	Milk containers	Empty	Plastic crates
5	Nail polish	Plastic bottles – 30 ml to 60 ml	Cartoned
5	Paper products	Tissue products including toilet rolls and paper towels	Uncartoned and plastic wrapped
5	Plastic containers	Combustible or non-combustible solids in plastic containers and empty plastic containers	None or cartoned
		Noncombustible liquids or semi-liquids (such as sauces) in plastic containers with nominal wall thickness greater than 6.4 mm and larger than 8.9 litre capacity	None or cartoned
5	Polyurethane	Foam	Cartoned
5	Rubber	Synthetic	
5	Stuffed toys	Foam or synthetic fill	None or cartoned
5	Textiles	Synthetics, except rayon and nylon – 50/50 blend or less	Baled fibre
		Synthetics, except rayon and nylon, thread, yarn – greater than 50/50 blend	Cartoned or uncartoned
		Synthetics, rayon and nylon, thread and yarn	On plastic spools
5	Vinyl floor coverings	Rolled	None
5	Vinyl-coated fabric	Rolled	None
5	Wax, paraffin	Blocks	Cartoned
5	Wax-coated paper	Cups, plates	Loose inside large cartons
5	Wire	Bulk storage of empty plastic spools	None
6	Expanded styrene products, exposed (uncovered)	Building products	None
		Food and beverage containers	None
		Insulation sheets	None
		Packaging mouldings	None
		Produce boxes	None
		Rolled sheets	None
6	Mattresses	Foam, in finished form	None or plastic wrapped
6	Polyurethane products, exposed (uncovered)	Architectural mouldings	None
		Cushioning	None
		Hose, seals and extruded products	None
		Rolled insulation	None
		Sheet lining material	None
		Wheels, gaskets and other component mouldings	None
Special	Aerosol	Levels 2 & 3	Cartoned
Special	Baled fibres	Solid piles	None
Special	Carpet	Rolls	None
Special	Distilled spirits	20 % to 50 % by vol.	Glass and PET bottles
		Up to 75 % by vol.	Wood or metal barrels
Special	Hanging garments	Clothing	None
Special	Pallets	Idle	None
Special	Roll paper	Light, med and heavyweight	Wrapped or banded
Special	Tyre storage	Rubber	None

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APPENDIX C – TESTING OF TERRITORIAL AUTHORITY WATER MAINS

(Normative)

C1

Before testing, arrangements should be made with the water supply authority and their requirements shall be observed during testing. Particular care should be taken to open and close hydrants slowly to avoid excessive water hammer.

C2 METHOD 1

C2.1

The flow and pressure characteristics of the main shall be determined using a flow gauge and pressure gauge attached by independent connections each going directly to the main, as close together as is practicable. Normally two adjacent fire hydrants will provide the points of attachment.

C2.2

The test shall be made during periods of maximum daily draw-off. The flow gauge shall be so placed with respect to the direction of water flow when the test is being conducted to give the lower reading on the pressure gauge. This is important for a main that is fed from one end only.

C2.3

Values of pressure and flow shall be recorded at not less than two and preferably three flow rates, one being as large as practicable, and used to prepare a graph relating pressure and flow. Pressure shall be plotted to a suitable scale on the ordinate ("y" axis) and the 1.85 power of the flow on the abscissa ("x" axis). The line relating pressure and flow (line A) shall be drawn.

C2.4

An adjustment shall be made to all test pressure readings to allow for the difference in height between the proposed sprinkler alarm valve and the test pressure gauge. The difference (calculated at 1 m = 10 kPa) should be marked on the graph above or below line A (as applicable). Draw a line (line B) through the points parallel to line A.

C2.5

Now make a further adjustment to allow for the frictional loss of pipework from the point of connection to the test main up to and including the sprinkler control valves. This loss is calculated at the highest design flow and is plotted below line B at that flow. A new line (line C) is now drawn through this plotted point and the intersection of line B and the "y" axis (see figure C1).

C2.6

The pressure available to meet the design requirements shall be taken as 80 % of the pressure indicated by line C of the graph at the design flow required.

C2.7

Where it can be established that proposed upgrading of the reticulation by the water supply authority will result in an improvement in the pressure and flow characteristics obtained at the time of the test, 100 % of the pressure indicated by line C of the graph may be taken subject to the approval of a Sprinkler System Certifier (SSC).

C3 METHOD 2

C3.1

The flow and pressure characteristics of the main shall be determined and a graph prepared as specified in C2.1 to C2.5 inclusive for method 1.

C3.2

In addition, a pressure recording gauge shall be used to ascertain the static pressure i.e. at no sprinkler flow of the main at the level at which it is proposed to install the sprinkler valves. The record shall be made for at least 14 consecutive days. If the water supply system is liable to seasonal fluctuation, the record shall be taken for at least 21 days during the season when the pressure is at its lowest. The contractor shall also check whether there is any evidence of downward fluctuation from year to year during the season of greatest demand. A SSC may require a further derating if such fluctuations occur.

C3.3

This pressure recording shall be inspected and the lowest pressure (other than transient low pressure readings occasioned by hydraulic shocks) noted. This pressure shall be marked on the graph where it intersects the 'y' axis and a line (line D) drawn through this point, parallel to line C. (See figure C1.)

C3.4

The pressure available to meet the design requirements shall be taken as 90 % of the pressure indicated by line D of the graph at the design flow required.

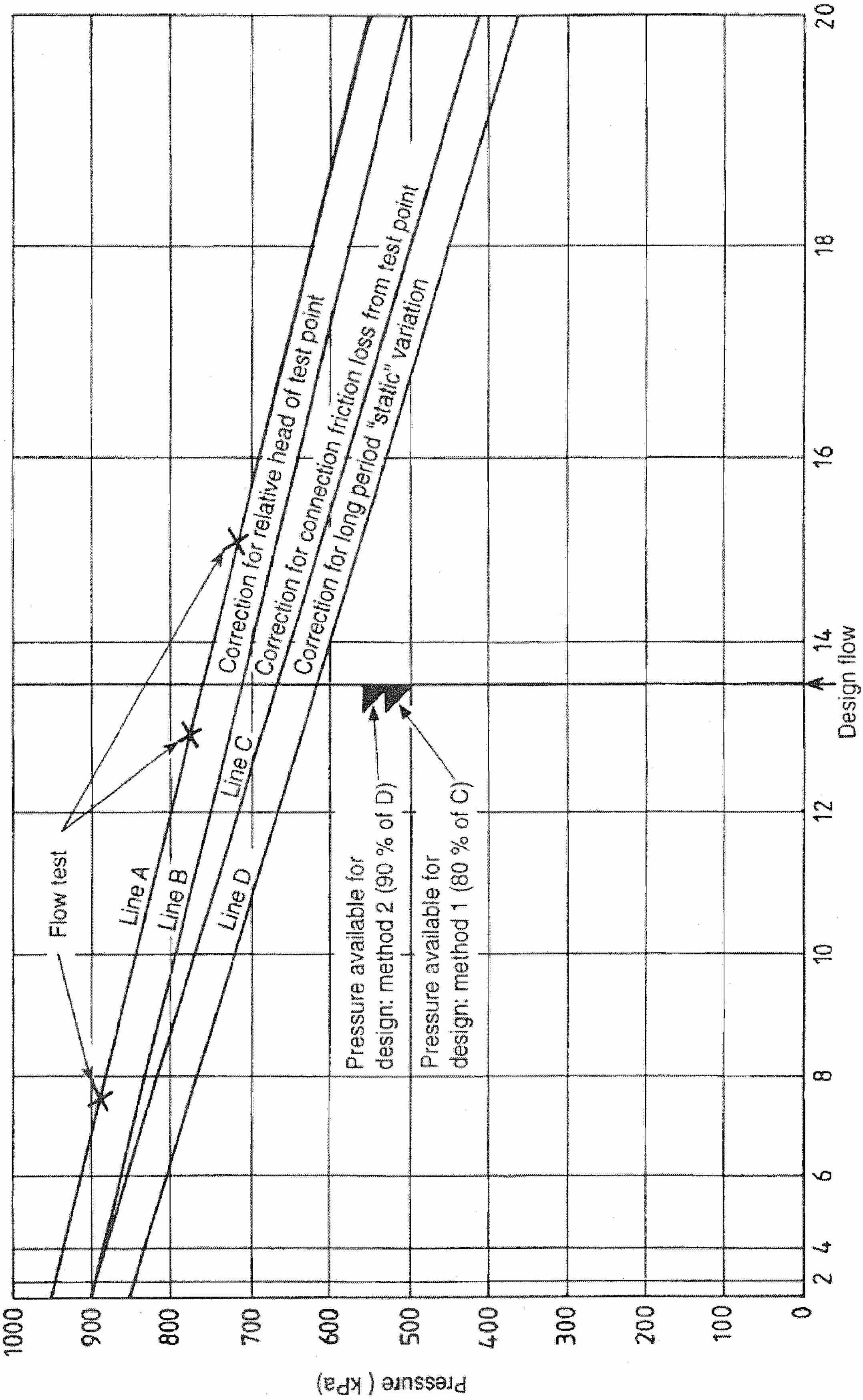

Figure C1 – Water supply flow graph

APPENDIX D – INFORMATION TO BE PROVIDED WHEN ORDERING A PUMP UNIT (SEE 607.1.3)

(Informative)

D1

(a) Name and address of intended location ....

(b) Required type of driver ....

(c) Altitude .... and site RL ....

(d) Atmospheric conditions: Marine
Corrosive
Temperature range
Humidity range

(e) Water source: Open water
Tank: .... RL full and .... RL empty level
Town's main (provide characteristic curve)
Other:

(f) Water quality: Saline or fresh
Temperature
Acidity

(g) Schedule of design flows and design pressure of each installation to be supplied and the hazard classification.

(h) Friction loss at highest design flow and static difference between:

  (i) Pump discharge and alarm valve of each installation

  (ii) Water source and pump suction.

(i) Any requirement for simultaneous hydrant flow.

(j) Number of start pressure switches.

(k) Preferences: Impeller material
Seals
Method of cooling

(l) If air cooled, details of ducting.

(m) Right angle drive requirement.

(n) Layout of pump enclosure including pump unit, controller, and on diesels, batteries and fuel tank.

(o) Specify if engine heating is required.

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APPENDIX E – ORIFICE PLATES

(Informative)

E1

Table E1 and table E2 should assist in calculating the appropriate diameter of orifice to achieve the desired hydraulic load.

The tables indicate correct orifice diameter for pipe sizes from 50 mm to 200 mm for discrete values of pressure loss (*Po*) in (kPa) for an assumed rate of flow (*Qo*) in L/min. Table E1 for the smaller diameter pipes is based on a flow of 500 L/min and table E2 for the larger diameter pipes, on a flow of 5000 L/min.

E2 USING OF TABLES E1 AND E2

To select an orifice plate which will produce a pressure loss of *Px* (kPa) with a rate of flow of *Qx* (L/min), calculate the value of *Po* from the following formula and refer to the appropriate table for the correct orifice diameter. Interpolate as necessary.

Pipe sizes: 50 mm and 65 mm

$$Po = Px\left(\frac{500}{Qx}\right)^2$$

Pipe sizes: 80 mm to 200 mm

$$Po = Px\left(\frac{5000}{Qx}\right)^2$$

The '*K*' factor referred to in the last column of these tables is the constant in the formula:

$$Q = K\sqrt{P}$$

Where *P* is the pressure loss (kPa) due to the orifice with a rate of flow of water Q (L/min).

The pressure loss produced by the orifice plate is the net pressure loss across the orifice and not the pressure difference measured at “flange”, “corner” or “D” and “D2” tapping points.

Table E1 – Pipes of 50 mm and 65 mm diameter and 500 L/min flow

Pressure loss (kPa)	**Orifice diameter** (mm) **Pipe size** (nominal bore) **50 mm**	**65 mm**	***K* factor**
250	25.9	–	31.6
225	26.5	–	33.3
200	27.1	–	35.4
175	27.9	–	37.8
150	28.8	–	40.8
125	29.6	–	44.7
100	30.9	–	50.0
90	31.5	–	52.7

Table E1 – Pipes of 50 mm and 65 mm diameter and 500 L/min flow (continued)

Pressure loss	**Orifice diameter** (mm)		
	Pipe size (nominal bore)		
(kPa)	**50 mm**	**65 mm**	***K* factor**
80	32.2	34.5	55.9
70	32.8	35.3	59.8
60	33.7	36.3	64.5
50	34.7	37.6	70.7
40	35.9	39.3	79.1
30	37.5	41.2	91.3
20	39.7	44.2	111.8
10	42.7	49.1	158.1
5	–	53.6	223.6

Table E2 – Pipes of 80 mm to 200 mm diameter and 5000 L/min flow

Pressure loss	**Orifice diameter** (mm)				
	Pipe size (nominal bore)				
(kPa)	**80 mm**	**100 mm**	**150 mm**	**200 mm**	***K* factor**
3500	41.9	–	–	–	84.5
3000	43.0	–	–	–	91.3
2500	44.8	–	–	–	100.0
2000	46.4	–	–	–	111.8
1500	48.9	–	–	–	129.1
1000	52.3	56.2	–	–	158.1
900	53.2	57.6	–	–	166.7
800	54.1	59.0	–	–	176.8
700	55.3	60.4	–	–	189.0
600	56.6	62.0	–	–	204.1
500	58.2	63.9	–	–	223.6
400	59.8	66.5	–	–	250.0
300	62.0	69.7	–	–	288.7
200	65.0	74.2	82.3	–	353.6
100	–	81.1	95.8	–	500.0
90	–	82.2	97.1	105.7	527.0
80	–	83.3	99.3	108.1	559.0
70	–	84.4	101.7	111.1	597.6
60	–	85.7	104.0	113.9	645.5
50	–	87.0	106.8	117.7	707.1
40	–	–	110.0	122.2	790.6
30	–	–	115.1	129.1	912.9
20	–	–	120.6	137.7	1118.0
10	–	–	–	152.6	1581.0
5	–	–	–	165.8	2236.0

APPENDIX F – RETROSPECTIVE UPGRADES

(Informative)

This Standard does not require that systems approved to previous editions of NZS 4541 be upgraded to comply with this edition of the Standard. For the purposes of complying with legislation, such as the New Zealand Building Code and the Fire Safety and Evacuation of Buildings regulations, existing sprinkler systems are certified as complying with previous editions of NZS 4541 may, for the purposes of that legislation, be deemed to meet the requirements of NZS 4541:2007.

This Appendix provides a recommendation on the minimum level of work necessary to ensure that system reliability is maintained at expected levels for systems installed to previous editions of this Standard.

Largely, these recommendations have been made after the review of fires or other events that have indicated the need to amend the Standard following such events. For example the recommendation for retrospective seismic upgrading was as a result of the Edgecombe Earthquake of 2 March 1987. The recommendation with respect to interfacing of air handling plant in EHH occupancies was as a result of a study of a fire in such occupancy, where an excessive number of sprinklers opened, after the air handling plant distorted the fire plume.

This edition of this Standard has, as its most significant change, the revision of High Piled Storage design criteria. It is not intended that existing warehouses and the like be upgraded to comply with the requirements of this Standard. It is expected that the occupier's insurers, on a cost effectiveness basis, would drive such an upgrading. If the warehouses change occupants, or significantly change the goods stored within them, the requirements to upgrade to the current standard would be driven by a combination of Building Consent requirements, and insurance interests.

See figure U3 for compliance flowchart.

F1 MINIMUM LEVEL OF RECOMMENDED RETROSPECTIVE UPGRADES

F1.1 Water systems installed to NZS 4541:1996 or NZS 4541:2003

Systems previously approved as complying with NZS 4541:1987 (up to and including Amendment No. 2) or NZS 4541:1996 (up to and including Amendment No. 2 and Supplement 1) or NZS 4541:2003:

(a) The requirements of 112.5 (display of compliance certificate), 203.6.1 (materials with high spread of flame index), and 511.10 (extractor hoods and ducts) should be complied with;

(b) The requirements of 105 and 403.12 and 403.13 (seismic resistance) should be complied with if the sprinkler system is located in an area of New Zealand designated in NZS 1170.5 as having a Z-factor greater than 0.13;

(c) The requirements of Part 12 (Routine Testing, Maintenance and Inspections) are complied with;

(d) The requirements of 903.7 (control of air handing plant in extra high hazard occupancies) meet compliance needs.

F1.2 ALL OTHER SYSTEMS

F1.2.1 General recommendations

All sprinklers systems, other than those systems previously approved as complying with NZS 4541:1987, NZS 4541:1996 or NZS 4541:2003, should comply with the following general recommendations:

(a) The requirements of 112.5, 203.3, 203.6, 403.9, 511.10, and 610 should be complied with;

(b) Petrol engine driven pumps should not form part of any water supply;

(c) The system should be tested and maintained in accordance with Part 12;

(d) Where any water supply is from a town's main, provided the characteristics of the main are evaluated using Method 2 of Appendix C, 100 % of the available pressure may be assumed to be available;

(e) Any diesel engine driven pump set, which predated the issue of the Insurance Council of New Zealand 'Diesel 2' specification, may continue to be accepted providing that there is satisfactory evidence of trouble-free starting and running;

(f) The automatic starting arrangements of any pump set which is remote from the control valves and which forms a part of a water supply should comply with 607.1.5 unless a Sprinkler System Certifier deems the existing arrangements to be sufficiently reliable;

(g) Every pump set should have a pressure/suction gauge on the suction pipe;

(h) Where distribution pipes are located at the lower end of a range pipe of slope greater than 1:4, the adequacy of the density in that section of the system should be determined by calculation in accordance with Part 10;

(i) Systems located in areas of New Zealand designated NZS 1170.5 as having a *Z* factor greater than 0.13 should comply with the requirements of 105;

(j) The requirements of Part 12 are complied with;

(k) The requirements of 903.7 (control of air handling plant in extra high hazard occupancies) meet compliance needs.

F1.2.2 Systems installed to NZS 4541P:1972

Systems previously approved as complying with NZS 4541P:1972 in which:

(a) Areas, which in terms of that Standard were classified as extra light hazard remain so classified;

(b) Areas, which in terms of that Standard were classified ordinary hazard, remain, after reference to a current declaration of storage intentions, so classified;

(c) Areas, which in terms of this Standard are classified extra high hazard have a design density and assumed maximum area of operation which, with reference to a current declaration of storage intentions and using the methods of calculation in Part 10, conform with this Standard.

In the case of a system where stored water forms part of any water supply and where, solely as a consequence of changes in density requirements between NZS 4541P:1972 and NZS 4541:1996, the required capacity has increased, approval should not be forfeited provided that 80 % of the required capacity is available.

F1.2.3 Systems approved as complying with Fire Offices' Committee Rules For Automatic Sprinkler Systems 29th Edition

Systems previously approved as complying with Fire Offices' Committee *Rules for automatic sprinkler installations*, 29th Edition, in which:

(a) In areas classified as extra light hazard by this Standard, the water supplies can each deliver 540 L/min to every six-sprinkler design point at a pressure of at least 75 kPa;

(b) In areas classified as ordinary hazard by this Standard (after reference to a current declaration of storage intentions) each water supply can deliver 1350 L/min at a pressure of 100 kPa to the distal end of every 65 mm distribution pipe. If, beyond that point, there is more than 3 m of distribution pipe between adjacent ranges, then each water supply should provide an average density of 5 mm/min when the entire array downstream of that pipe is operating;

(c) Capacity of water storage tanks forming part of a primary supply should be at least 60 minutes at the design flow and, of a secondary supply, at least 30 minutes if there is a single set of control valves, or 40 minutes if there is more than one set of control valves;

(d) In areas classified as extra high hazard by this Standard, the system (including water supplies) complies with Part 9.

F1.2.4 Systems approved as complying with the council of Fire and Accident Underwriters' Association of New Zealand rules for light hazard sprinkler systems

Systems previously approved as complying with the Council of Fire and Accident Underwriters' Association of New Zealand Rules for Light Hazard Sprinkler Systems, in which:

(a) Each water supply will deliver 300 L/min at a pressure of 75 kPa to every four-sprinkler design point in every area classified extra light hazard by this Standard;

(b) Each water supply is shown by calculation to deliver an average density of 5 mm/min over any area of 216 m^2 classified as ordinary hazard by this Standard. With all sprinklers operating in such an area, there should be a pressure of at least 35 kPa at each sprinkler. Capacity of water storage tanks forming part of a primary supply should be at least 60 min at the design flow and, of a secondary supply, at least 30 min if there is a single set of control valves, or 40 min if there is more than one set of control valves.

In areas classified extra high hazard by this Standard, the system (including water supplies) complies with Part 9.

APPENDIX G – RECOMMENDATIONS FOR FROST PROTECTION MEASURES FOR FIRE SPRINKLER SYSTEMS

(Informative)

G1

The need to protect a fire sprinkler system from the effects of freezing is easily understood. Freezing of water within the sprinkler pipework could result in two effects:

(a) Damage to the pipework, fittings or ancillary equipment, causing subsequent water leakage and property damage; and

(b) Systems rendered inoperative due to ice blockage and hence not able to deliver water to control a fire.

The ability to understand when a sprinkler system, or part of a system, will freeze is not so obvious and careful consideration of the environment surrounding a sprinkler system and other consequential factors need to be studied. A building located in an area that will be subject to freezing ambient temperatures does not necessarily mean that the sprinkler system protecting that building will also be subject to those temperatures.

Premises have many areas which could be subject to freezing temperatures, for example:

(c) Unheated or inadequately heated buildings;

(d) Parts of heated buildings exposed to frost, such as ceiling voids or near open doors to loading bays;

(e) Chillers and cold rooms;

(f) External pipelines from a remote mains water supply to the protected building;

(g) The pumphouse or a remote valve set;

(h) Areas normally heated but temporarily unheated during out-of-hours, weekends or winter holidays.

The methods available for protecting areas with water filled equipment from freezing are:

(i) Maintaining adequate heating throughout the building;

(j) Providing localised heating and/or trace heating and lagging;

(k) Using dry-barrel sprinklers;

(l) Using a dry pipe sprinkler system or tail-end dry pipe sprinkler system;

(m) Using an antifreeze sprinkler installation or tail-end antifreeze sprinkler installation.

Sprinkler systems inside the thermal envelope of a heated building will normally be adequately protected against low ambient temperatures provided ambient temperatures are maintained above 4 °C at all times. Buildings that will not have heating applied at all times such as out-of-hours, weekends or winter holidays will need to be assessed for what freeze protection options may be required or whether a wet pipe system is suitable. Current building practice tends to ignore heating to buildings during periods of non-occupancy. It should be noted that most heating systems, particularly those based on northern hemisphere technology, do have a frost protection function that will allow heating to maintain a background temperature of 4 °C during out-of-hours periods.

Current building practices also lean towards the building insulation membrane being placed directly above the ceiling as opposed to under the roof cladding. This leaves the ceiling space outside of the heated area of the building. Services in this area could therefore be subject to low ambient temperatures. In buildings that will be sprinkler protected the requirement for the system to be located within the thermal envelope of the building will need to be stressed to the building professionals to ensure that the needs of the sprinkler system are recognised. For buildings with 24-hour occupancy and which are located in more temperate regions it may be acceptable to rely on heat leakage through ceiling mounted insulation.

Where sprinkler pipework that is generally inside a heated building but will have some pipe exposed to frost, such as cold roof spaces, unheated building or annex, or in cold areas adjacent to large door openings, such pipework should be trace-heated and lagged. Pipe lagging is bulky. It is essential that sprinkler heads are not obstructed by the lagging or the trace-heating cables. The trace-heating cables should be affixed to pipework opposite the sprinkler heads. It should also be noted that the increased diameter of the lagged pipework will increase the shadow of upright sprinklers. Some pipework design changes may be necessary to overcome the possibility of lagging interfering with sprinkler spray patterns. For example, it may be desirable to connect the sprinklers to the range pipe using rise or drop pipes.

Where the main sprinkler piping is adequately protected against frost, because of its location in a warm area, but the sprinkler heads are located in an immediately adjacent cold area, dry barrel pendent, upright or horizontal sidewall sprinklers may be used. It is important that the manufacturers' installation instructions are followed to ensure that an adequate length of dry barrel sprinkler is selected to prevent freezing at the water-filled pipe end.

For tail-end dry pipe installations see 302.3.

For tail-end antifreeze systems see 302.6.

G2 FROST PRECAUTIONS FOR WATER SUPPLIES

(The following comments apply equally to Dry Pipe, Preaction, Deluge and Antifreeze systems.)

G2.1 Underground water supply pipework

Underground water supply pipework is generally sufficiently protected against freezing due to its position and require no further frost precautions. Underground pipework in alpine regions should be at a depth of 750 mm or more. It may generally be assumed that the short vertical buried section below the point of emergence from the ground is kept adequately warm from above and below.

G2.2 Water supply pipework

Exposed water supply pipework that is not inside a permanently heated building should be suitably lagged over the exposed length. Short sections of exposed pipe greater than 65 NB may not necessarily require protection due to the effects of thermosyphoning but the merits of each individual system should be assessed. In colder climates the use of trace-heating should be seriously considered especially on pipework smaller than 65 NB.

G2.3 Valvehouse enclosures

Valvehouse enclosures or valve cabinets that are outside the thermal envelope of the building shall be maintained at or above a temperature of 4 °C.

G2.4 Water storage tanks

Above-ground water storage tanks that may be susceptible to freezing should be fitted with immersion heaters fitted adjacent to the ball float valve to keep the ball float free of ice. This also prevents ice from forming a complete seal across the water surface and allows the water level to fall as the water is pumped from beneath the ice covering.

Pressure tanks should be housed in an enclosure maintained at or above a temperature of 4 °C. Underground tanks are generally sufficiently protected against freezing due to their position and require no further frost precautions but the merits of each individual tank should be assessed.

G2.5 Electricity supplies and controls

The electrical supply for all frost protection systems should be fed from a reliable dedicated supply to ensure that supplies are not inadvertently switched off during holiday shutdowns or maintenance periods.

The electrical supplies to the various frost prevention areas should have indicator lights to show that power is on. Site procedures should be devised and documented to ensure that power supplies are switched on before winter and off when the risk of frost has passed.

Heating systems, including room heating and trace-heating, are controlled using a combination of time-clock switches, thermostats and frost-stats. A frost-stat is a thermostat used to over-ride any time-clock switch and turn on the heating system in the event of the air temperature falling to near freezing. Once the heating has been turned on it will often be controlled locally by a separate thermostat. The frost-stat is usually positioned outside or at the coldest part of the building, to turn on the heating as soon as possible. Frost-stats for valvehouse and water tank heating could operate both as a frost-stat and thermostat for controlling the temperature.

APPENDIX H – *Z*-VALUES AND SHORTEST MAJOR FAULT DISTANCES *D* FOR NEW ZEALAND

(Informative)

H1 REPRODUCED FROM NZS 1170.5

Users should refer to the current version of that Standard for authoritative information.

Table H1 – *Z*-values and shortest major fault distances *D* for New Zealand locations (north to south)

#	Location	*Z*	*D* (km)*
1	Kaitaia	0.13	-
2	Paihia/Russell	0.13	-
3	Kaikohe	0.13	-
4	Whangarei	0.13	-
5	Dargaville	0.13	-
6	Warkworth	0.13	-
7	Auckland	0.13	-
8	Manakau City	0.13	-
9	Waiuku	0.13	-
10	Pukekohe	0.13	-
11	Thames	0.16	-
12	Paeroa	0.18	-
13	Waihi	0.18	-
14	Huntly	0.15	-
15	Ngaruawahia	0.15	-
16	Morrinsville	0.18	-
17	Te Aroha	0.18	-
18	Tauranga	0.20	-
19	Mount Maunganui	0.20	-
20	Hamilton	0.16	-
21	Cambridge	0.18	-
22	Te Awamutu	0.17	-
23	Matamata	0.19	-
24	Te Puke	0.22	-
25	Putaruru	0.21	-
26	Tokoroa	0.21	-
27	Otorohanga	0.17	-
28	Te Kuiti	0.18	-
29	Mangakino	0.21	-
30	Rotorua	0.24	-
31	Kawerau	0.29	-
32	Whakatane	0.30	-
33	Opotiki	0.30	-
34	Ruatoria	0.33	-
35	Murupara	0.30	-
36	Taupo	0.28	-
37	Taumarunui	0.21	-
38	Turangi	0.27	-
39	Gisborne	0.36	-
40	Wairoa	0.37	-
41	Waitara	0.18	-
42	New Plymouth	0.18	-
43	Inglewood	0.18	-
44	Stratford	0.18	-
45	Opunake	0.18	-
46	Hawera	0.18	-
47	Patea	0.19	-
48	Raetihi	0.26	-
49	Ohakune	0.27	-
50	Waiouru	0.29	-
51	Napier	0.38	-
52	Hastings	0.39	-
53	Wanganui	0.25	-
54	Waipawa	0.41	-
55	Waipukurau	0.41	-
56	Taihape	0.33	-
57	Marton	0.30	-
58	Bulls	0.31	-
59	Feilding	0.37	-
60	Palmerston North	0.38	8 – 16
61	Dannevirke	0.42	10
62	Woodville	0.41	≤ 2
63	Pahiatua	0.42	8
64	Foxton/Foxton Beach	0.36	-
65	Levin	0.40	-
66	Otaki	0.40	-
67	Waikanae	0.40	15 – 20
68	Paraparaumu	0.40	14 – 20
69	Masterton	0.42	6 – 10
70	Porirua	0.40	8 – 12

#	Location	*Z*	*D* (km)*
71	Wellington CBD (north of Basin Reserve)	0.40	≤ 2
72	Wellington	0.40	0 – 8
73	Hutt Valley – south of Taita Gorge	0.40	0 – 4
74	Upper Hutt	0.42	≤ 2
75	Eastbourne – Point Howard	0.40	4 - 8
76	Wainuiomata	0.40	5 – 8
77	Takaka	0.23	-
78	Motueka	0.26	-
79	Nelson	0.27	-
80	Picton	0.30	16
81	Blenheim	0.33	0 – 5
82	St Arnaud	0.36	≤ 2
83	Westport	0.30	-
84	Reefton	0.37	-
85	Murchison	0.34	-
86	Springs Junction	0.45	3
87	Hanmer Springs	0.55	2 – 6
88	Seddon	0.40	6
89	Ward	0.40	4
90	Cheviot	0.40	-
91	Greymouth	0.37	-
92	Kaikoura	0.42	12
93	Harihari	0.46	4
94	Hokitika	0.45	-
95	Fox Glacier	0.44	≤ 2
96	Franz Josef	0.44	≤ 2
97	Otira	0.60	3
98	Arthurs Pass	0.60	12

#	Location	*Z*	*D* (km)*
99	Rangiora	0.33	-
100	Darfield	0.30	-
101	Akaroa	0.16	-
102	Christchurch	0.22	-
103	Geraldine	0.19	-
104	Ashburton	0.20	-
105	Fairlie	0.24	-
106	Temuka	0.17	-
107	Timaru	0.15	-
108	Mt Cook	0.38	-
109	Twizel	0.27	-
110	Waimate	0.14	-
111	Cromwell	0.24	-
112	Wanaka	0.30	-
113	Arrowtown	0.30	-
114	Alexandra	0.21	-
115	Queenstown	0.32	-
116	Milford Sound	0.54	-
117	Palmerston	0.13	-
118	Oamaru	0.13	-
119	Dunedin	0.13	-
120	Mosgiel	0.13	-
121	Riverton	0.20	-
122	Te Anau	0.36	-
123	Gore	0.18	-
124	Winton	0.20	-
125	Balclutha	0.13	-
126	Mataura	0.17	-
127	Bluff	0.15	-
128	Invercargill	0.17	-
129	Oban	0.14	-

* The near-fault factor *N*(*T*,*D*) should be considered for locations with the distance *D* to the nearest major fault specified.

APPENDIX J – SPRINKLER PROTECTION DESIGN REQUIREMENTS FOR BUILDINGS CONSTRUCTED WITH FOAMED PLASTIC CORED INSULATED PANELS

(Normative)

J1 INTRODUCTION – FACTORY FORMED INSULATED PANELS

Over the past decade the use of factory formed insulated panels with foamed plastic cores for the construction of external cladding and internal partitioning of commercial and industrial buildings has significantly increased. In the same period large fire losses have been incurred worldwide and many have been associated with fires in which insulated panelling using a foamed plastic combustible core material have been a feature.

A number of these fires featured rapid fire development. Foamed plastic cored panelling used for the construction of the building envelope or internal partitioning can substantially add to the fire loads found in many commercial and industrial buildings and in particular critical hygiene areas in food industry processing and cold storage buildings. In particular the thermoplastic foamed cored panels have been involved with an increasing number of large losses.

The potential to ignite the core material is dependent on the proximity to the panel of the fire load and the size and duration of the ignition source. Under fire conditions any substantial fire inside, or outside, the building which is in contact with or in close proximity to the thermoplastic cored panels will cause the panel face to heat up. As the temperature of the metal sheet increases, the thermoplastic core insulation material draws away from the heated surface causing an air gap within the panel. The shrinkage of the core material away from the steel skins can cause early structural failure of the panels and this is known as delamination. As the temperature of the adjacent fire continues to rise, the core insulation material starts to melt and pool at the bottom of the panels causing further delamination and structural failures.

With the temperature of the adjacent fire continuing to rise the thermoplastic materials, which have been treated with a fire retardant additive can reach ignition temperature and will begin to burn. This process continues the delamination of adjacent panels exposing additional foamed plastic material, which can further spread the fire.

Where the ignition source is sufficiently large, or where the contents of the building or adjoining building are already burning, foamed plastic cored panels can make a significant contribution to the fire loadings.

Fire Services worldwide are concerned with the speed at which these fires spread, the intense heat released on the delamination of the panels and the high levels of smoke and products of combustion released from a fire in this type of panel. The early structural failure of the panels makes conventional methods of firefighting difficult and exposes firefighters to a substantial risk from structural failure, often with catastrophic results. It is difficult to predict the path of spread through voids particularly when large panels are used. As the heat, fire and smoke spreads through the core further delamination occurs with the steel skins peeling back, increasing the rate of propagation. Firefighting techniques then become defensive trying to restrict spread to other buildings or beyond true fire breaks.

To combat these problems there needs to be strong management controls over the installation and maintenance of the panels and suitable fixed fire suppression systems to minimise possible losses and damage to plants.

Following a number of full scale fire tests in America by FM Global and the United Kingdom by LPCB it has been found that protection provided in existing sprinkler Standards for the Extra Light and Ordinary hazard categories may not in some circumstances be adequate to control a fire that has spread from a source adjacent to these panels and prevent additional foamed plastic core materials becoming involved.

J2 Additions to the existing requirements for sprinkler protection

Clauses 212 to 212.5.2 have been developed for the NZ 4541 based on information from the full scale fire tests and are additions to the existing sprinkler requirements for the relevant occupancy Fire Hazard categories in the building. The additional requirements are designed to both control a fire in stored materials or processes adjacent to the insulated panels and to prevent a fire from involving the core materials.

J3 Generic classes of foamed plastics used in the insulated panel construction for building envelopes and internal partitions in buildings

The following are the generic classes for foamed plastics:

(a) Manufactured combustible foamed plastic cored insulated panels, or any other manufactured combustible foamed plastic cored insulated panels that have not been tested or certified by an accredited laboratory in accordance with ISO 9705, FM Approval Standard 4880 or LPCB LPS 1181 part 1, part 2 or LPS 1208. See 212.1.

(b) Approved foamed thermosetting plastic cored insulated panels (e.g. Phenolic/EPS composite and PIR foamed plastics), or other new foamed plastic cored insulated panels, or noncombustible core materials that have been fully tested and certified by an accredited laboratory in accordance with the testing criteria of ISO 9705, FM Approval Standard 4880 or LPCB LPS 1181 Part 1, Part 2 or LPS 1208 and that can provide listed ratings and similar fire performance certificates. **For this category of panel a fully compliant NZS 4541 sprinkler installation provided in a building and designed for the occupancy Fire Hazard category will be considered adequate to protect the risk.**

Approved panels shall be installed and maintained strictly in accordance with the manufacturer's instructions for installation and fitting detailing requirements specified in the accredited test schedules. All openings and penetrations through the panelling must be sealed with proprietary sealants and fixing details that retain the integrity of the panels in accordance with the manufacturer's detailings and requirements specified in the accredited test schedules.

A SSC shall be notified of any new or modified research data provided by accredited test laboratories on plastic products used for the construction of a building, or surface treatments, or insulated panel core materials and advice shall be sought on suitable sprinkler protection required.

A SSC shall be consulted on the use of any new or modified plastic products used for the construction of a building, the surface treatment, or the insulated panel core materials and advice sought on suitable sprinkler protection required.

NOTE –

(1) Approved panels – those factory manufactured insulated panels and fixing detailings that have been subjected by the manufacturers to fire performance certification processes at accredited test laboratories. As an example, ISO 9705, FM Global FM Approval Standard 4880, or the Loss Prevention Certification Board (LPCB) Certification, - LPCB LPS 1181 Part 1, Part 2 or LPS 1208 or any other such fire test facilities that can provide a listed rating and similar fire performance certificates.

(2) Insulated panels – a factory prefabricated insulated construction system delivered to site ready for installation, having an internal metal skin, an insulation core and an outer metal skin. The two metal skins are either glued or bonded together with the core material in the factory by the manufacturer.

(3) FM Global is an American based international insurance company that operate their own in-house test facility recognised worldwide. To achieve certification by FM Global factory manufactured insulated panels are assessed to FMRC 4880 (1994) – Approval requirements for Class 1 fire classification.

Achievement of Class 1 is dependent on performance of fire tests that include:

(i) ASTM E84 Surface burning characteristics;
(ii) ASTM D482 Ignition residue tests;
(iii) ASTM E711 Oxygen bomb tests;
(iv) UBC 26-3 Room test;
(v) FM 4800 50 ft Corner test.

For more information contact FM Global.

(4) Loss Prevention Certification Board (LPCB) Certification

The Loss Prevention Certification Board is part of the United Kingdom Building Research Establishment.

LPCB has developed standards following full scale tests under the following:

(i) LPS 1181 Part 1 2005 – External envelopes
(ii) LPS 1181 Part 2 2005 – Internal enclosures
(iii) LPS 1208 2005 – LPCB fire resistance requirements for elements of construction used to provide compartmentation.

J4 Smoke growth rate index ($\text{SMOGRA}_{\text{RC}}$)

The determination of the smoke growth rate shall be as set out in ISO 9705. To determine the smoke growth rate index ($\text{SMOGRA}_{\text{RC}}$):

(a) Measure the instantaneous rate of light-obscuring smoke R_{inst} expressed in m^2/s in the exhaust duct at not more than 6 second intervals in the ISO 9705 room test;

(b) Determine the 60 second running average (R_{60}) at time t. The result is the average rate of light-obscuring smoke over the period t-30 to t+30 seconds (in m^2/s). This may also be expressed mathematically as:

$$R_{60} = \frac{1}{60} \int_{t-30}^{t+30} R_{inst}\,dt$$

(c) Find the time (in seconds) at which the maximum value of the 60 second running average occurs (t_{60});

(d) Calculate the $\text{SMOGRA}_{\text{RC}}$ index (in $m^2/s^2 \times 1000$)

$$\text{SMOGRA}_{\text{RC}} = \frac{1000 R_{60}}{t_{60}}$$

The $\text{SMOGRA}_{\text{RC}}$ index is based on the results of a single test.

APPENDIX K – AEROSOLS – SUPPLEMENTARY DESIGN CONSIDERATIONS

(Normative)

K1 CLASSIFICATION OF AEROSOL HAZARD LEVEL

Aerosol products are classified into three hazard levels by calculating the sum of the chemical heat of combustion for the constituent components (e.g. propellant, liquid products, etc.) multiplied by their weight fraction.

The protection criteria for aerosols, as specified in 907.7, applies only to aerosol products packaged in cartons.

K1.1 Classification

The classification of aerosol products shall be in accordance with table K1. Calculation of the chemical heat of combustion for aerosol products shall be by one of the following methods:

(a) Sum the chemical heat of combustion for the constituent components of the aerosol product (e.g. propellant, liquid products, etc.) multiplied by their weight fraction.

This is represented in mathematical notation by the following formula:

$\Delta H_{cht} = \sum x_i \, \Delta H_{chi}$

where ΔH_{cht} = total chemical heat of combustion of the product, kJ/g.

x_i = weight fraction of component i

ΔH_{chi} = chemical heat of combustion of component i

(b) Use figure K1 if the aerosol's constituent materials are known and consist of saturated hydrocarbons, such as propane and isobutane, or alcohols, such as ethanol or methanol, and inert materials.

(c) Conduct a 12-pallet test to determine the aerosol classification, if product compositions are not known, (see *CK*1.1).

(d) Classify the aerosol product as Level 3, if product compositions are not known and test results are not available.

Table K1 – Aerosol classification

	Greater than: kJ/g	And less than or equal to:	Then, the aerosol hazard level shall be:
If the chemical heat of combustion:	0	20 kJ/g	1
	20	30 kJ/g	2
	30	–	3

CK1.1 Aerosol products

General

The typical aerosol container is a small, welded-joint high strength container (design pressures are as high as 1650 to 2750 kPa) used to package a wide variety of consumer, industrial, and pharmaceutical products. A partial list of products would include air fresheners, starches, cleaners, shaving creams, furniture polishes, hair sprays, deodorants, spot removers, insecticides, lubricants, engine degreasers and paints. Aerosol cans have capacities up to 950 ml, containing up to 450 g of liquid.

Propellants include propane and butane which are highly flammable, and other gases such as nitrogen, carbon dioxide, and nitrous oxide. Although nitrous oxide is a stable non-flammable gas, it is an oxidiser. Non-flammable chlorofluorocarbons have been eliminated for almost all uses, and have been replaced with mixtures of propane and butane.

Propellants in aerosol containers are 0.5 % to more than 90 % of the weight of the contents.

Aerosols have been grouped into Levels 1, 2 and 3. Level 1 Aerosols represent the lowest fire hazard; Level 3 represents the highest fire hazard.

Level 1 Aerosol products

Level 1 products include shaving cream, spray starch, window cleaner, alkaline oven cleaners, rug shampoos, some air fresheners and some insecticides. The storage hazard of Level 1 Aerosols is about the same as ordinary combustible goods in cartons. Storage should be arranged and protected accordingly.

When a Level 1 Aerosol can fails, the non-flammable product has a quenching effect on the flammable contents. Some products have very small quantities of flammable product. These products will have an overall chemical heat of combustion that is low.

Level 2 Aerosol products

Level 2 products include many personal care products such as deodorants (except for oil-based anti-perspirants), hair sprays, antiseptics and anaesthetics. Other products may include some furniture polishes, windshield de-icers, etc.

Level 3 Aerosol products

Level 3 products include many automotive products (engine and carburettor cleaners, undercoats), home products (some wood polishes), paints and lacquers, lubricants, some insecticides and oil-based anti-perspirants.

Aerosol classification by chemical heat of combustion

Test data indicates the overall fire hazard of an aerosol product is a function of the chemical heat of combustion. The chemical heat of combustion is the product of the theoretical heat of combustion and a combustion efficiency. Typical chemical heats of combustion are provided in table K3. A typical combustion efficiency is 95 %. Research conducted at Factory Mutual Global research correlated the chemical heat of combustion with results of 12-pallet tests to provide a classification methodology based exclusively on chemical heat of combustion. Figure K1 is based on this methodology.

Based on the results of the 12-pallet testing and aerosol flammability testing, liquids with a flash point that exceed 260 °C (e.g. some vegetable cooking oils) can be considered inert when classifying an aerosol product. In addition solids (e.g. powders), non-flammable gases (e.g. carbon dioxide), or non-flammable liquids (e.g. water) are also considered inert.

Aerosol flammability test

This test involves two procedures: a single can test and a pan fire test. The single can procedure exposes a restrained can to a predetermined heat source until it ruptures. The time to rupture is noted, and the fireball energy is measured in a Fire Products Collector (FPC). This data is combined to produce a 'single-can index' that allows the results to be compared with data produced by large-scale tests on known Level 1, 2 or 3 Aerosols.

Large scale tests, conducted to check the validity of the single can test, showed that the small scale test accurately predicted the large scale fire behaviour for most formulae.

There was an indication, however, that the single can test was inadequate for aerosols containing material that pooled on the floor and flash vaporised when hit by sprinkler discharge. As a result, the pan fire test was devised, consisting of burning a sample of aerosol contents for a set time period before applying water. This test shows whether the burning rate increases or whether the water extinguishes the fire.

Pallet test

The 12-pallet test was developed as part of the Aerosol Flammability Test (AFT) programme to confirm the accuracy of the AFT methodology. It is conducted using a 2 × 2 × 3 pallet array under a 7.6 m high ceiling with large-drop sprinklers designed to discharge at 345 kPa. Data collected during this test include the number of operating sprinklers, maximum steel and air temperatures, and plume temperature and plume velocity. This data is used to objectively determine the hazard classification.

Aerosol can labelling

Some aerosol cans are labelled 'Extremely Flammable' or 'Flammable', but these designations have no relation to the classification of the aerosol. Test data shows that mixtures that contain 55 % petroleum liquid and 45 % non-flammable liquid have significantly reduced burning characteristics relative to 100 % petroleum-liquid products. If the product is composed of 25 % to 55 vb % petroleum-liquid and the remainder is non-flammable, it can be treated the same as a Level 2 Aerosol. Testing indicates that the addition of methylene chloride to the product may increase the fire hazard. Until more is known about the effects of methylene chloride, Level 2 products containing methylene chloride should be treated as a Level 3 Aerosol.

K1.2 Sources for chemical heat of combustion

The chemical heat of combustion for the constituents of an aerosol product shall be determined from one of the following sources:

(a) The chemical heat of combustion data compiled in table K3, when the exact aerosol product components and their weight fractions are known;

(b) The total heat of combustion, as determined by oxygen bomb calorimeter measurements, when the exact aerosol product components and their weight fractions are known but the chemical heat of combustion is not available;

(c) The values provided in table K2 when the exact components of the aerosol product are not known but the product can be broken down by weight per cent into the generic groups of hydrocarbon (e.g. propellant, non-water miscible flammable liquids), alcohol (e.g. ethanol, isopropanol, etc.), and inert products (e.g. solids, non-flammable liquids);

(d) Results of an oxygen bomb calorimeter test on the aerosol product mixture including the propellant.

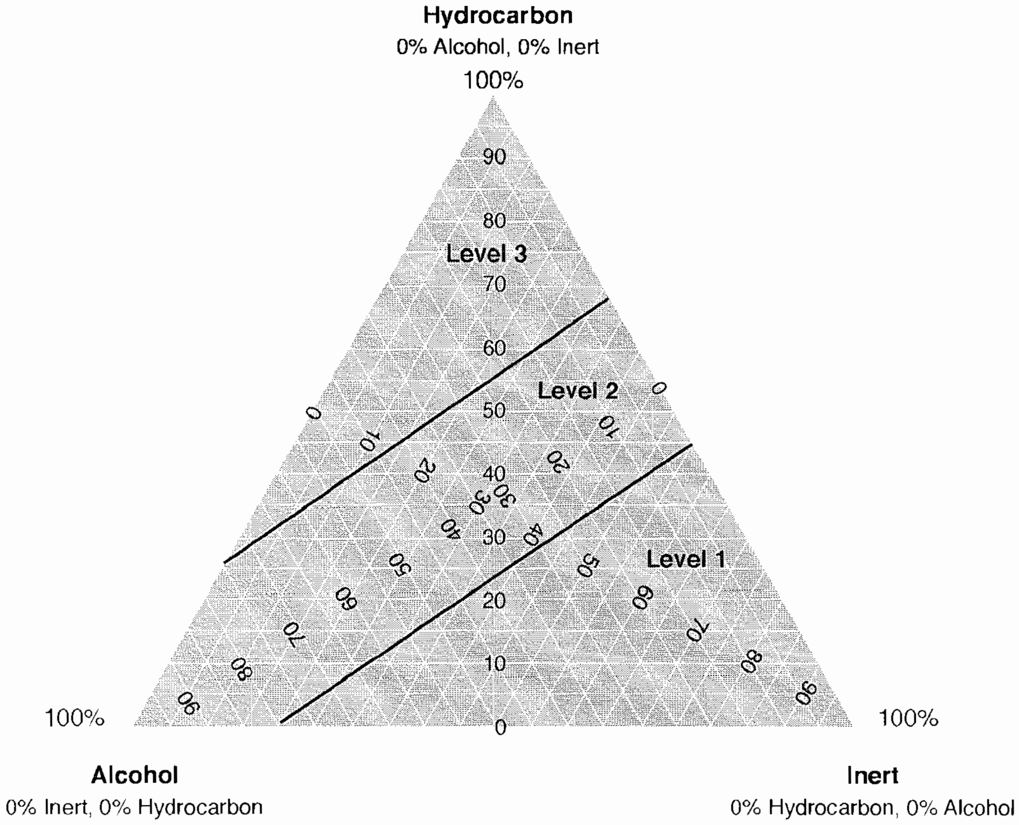


Figure K1 – Aerosol classification

NOTE – Materials should be considered inert if they are liquids with a flash point that exceeds 260 °C (e.g. some vegetable cooking oils), solids (e.g. powders), non-flammable gases (e.g carbon dioxide), or non-flammable liquids (e.g. water).

Table K2 – Chemical heat of combustion for various materials

Material	ΔH_{ch}, kJ/g
Hydrocarbon	44
Alcohol	25
Inert	0

Table K3 – Chemical heat of combustion data

CAS# (1)	Material Name	ΔH_C(2) (kJ/g)	X_{CH}(3)	ΔH_{CH}(4) (kJ/g)
71-55-6	1, 1, 1 –Trichloroethane	–	–	A(5)
75-37-6	1,1-Diflouroethane (HFC 152a)	18.1	0.35	6.3
95-63-6	1,1,1-Trimethyibenzene (Pseudocumene)	41.0	0.67	27.5
1717-00-6	1,1-Dichloro-l-Fluoroethane	8.4	0.35	2.9
110-71-4	1,2-Dimethoxyethane	26.7	0.97	25.9
75-68-3	1-Chloro-1,1-Diflouroethane (HCFC 142b)	9.3	0.35	3.3
108-65-6	1-Methoxy-2-Propanol Acetate	32.2	0.96	30.9
111-76-2	2-Butoxyethanol	30.8	0.96	29.6
110-80-5	2-Ethoxyethanol	26.7	0.97	25.9
111-15-9	2-Ethoxyethyl Acetate	32.2	0.96	30.9
75-28-5	2-Methylpropane (isobutane)	45.5	0.94	42.8
67-64-1	Acetone	28.6	0.97	27.7
68122-72-5	Acrylic Resin	–	–	A(5)
68122-72-5	Alkyd Resin	–	–	A(5)
7429-90-5	Aluminum	–	–	A(5)
8052-42-4	Asphalt	30.2	0.75	22.7
7727-43-7	Barium Sulfate	0.0	–	0.0
92-87-5	Benzidine (Yellow)	–	–	A(5)
106-97-8	Butane	45.6	0.95	43.3
85-68-7	Butyl Benzi Phthalate	37.1	0.85	3.15
1317-65-3	Calcium Carbonate	0.0	–	0.0
124-38-9	Carbon Dioxide	0.0	–	0.0
1333-86-4	Carbon Black	–	–	A(5)
1308-14-1	Chrominum Hydroxide	0.0	–	0.0
8001-30-7	Corn Oil	36.8	0.96	35
5989-27-5	d-Limonene	45.2	0.88	39.8
123-42-2	Diacetone Alcohol	37.3	0.94	35.1
112-34-5	Diethylene Glycol Methyl Ether	34.4	0.96	33.0
115-10-6	Dimethyl Ether	28.8	0.92	26.5
34590-94-8	Dipropylene Glycol MethylEther	33.5	0.96	32.2
64-17-15	Ethanol (95.6 Azeotrope)	25.6	0.92	23.6
64-17-15	Ethanol	26.8	0.92	24.7
763-69-9	Ethyl 3-Ethoxypropionate	33.3	0.96	32.0
100-41-4	Ethyibenzene	40.9	0.71	29.0
107-21-1	Ethylene Glycol	16.9	0.97	16.4
111-55-7	Ethylene Glycol Diacetate	33.3	0.96	32.0

CAS# (1)	Material Name	ΔH_C(2) (kJ/g)	χ_{CH}(3)	ΔH_{CH}(4) (kJ/g)
7782-42-5	Graphite	–	–	A(5)
107-41-5	Hexylene Glycol	29.7	0.96	28.5
1309-37-1	Iron Oxide	0.0	–	0.0
78-83-1	Isobutyl Alcohol	32.7	0.91	29.8
108-21-4	Isopropyl Acetate	26.0	0.98	25.5
67-63-0	Isopropyl Alcohol	30.1	0.91	27.4
142-91-6	Isopropyl Paimitate	38.8[2]	0.96	37.2
110-27-0	Isopropyl Myristate	38.9	0.95	36.2
1332-58-7	Kaolin Clay (Aluminum Silicate Hydroxide)	0.0	–	0.0
8008-20-6	Kerosene (Kerosine)	46.0	0.90	41.4
—	Liquids, Non-contributory	–	–	A(5)
—	Liquids, Noncombustible/Flammable	0.0	0.0	
14807-96-6	Magnesium Silicate (Talc)	0.0	–	0.0
67-56-1	Methanol	20.0	0.953	19.0
78-93-3	Methyl Ethyl Ketone	31.5	0.973	30.6
563-80-4	Methyl Isopropyl Ketone	33.1	0.94	31.1
110-43-0	Methyl n-Amyi Ketone	37.2	0.94	35.0
75-09-2	Methylene Chloride	6.0	0.35	2.1
12001-26-2	Mica (Mica Silicate)	0.0	–	0.0
64742-47-8	Mineral Spirits (Petroleum Distillate)	44.8	0.92	41.2
8012-95-1	Mineral Oil	41.5	0.76	31.5
64742-88-7	Mineral Spirits (Petroleum Distillate)	44.8	0.92	41.2
134-62-3	N,N-Diethyl- m-Toluamide (Deet)	38.1	0.74	28.2
123-86-4	n-Butyl Acetate	28.2	0.98	27.6
142-82-5	n-Heptane	44.6	0.92	41.0
110-54-3	n-Hexane	44.7	0.92	41.1
113-48-4	n-Octyl Bicyclopheptane Dicarboximide	38.0	0.79	30.0
64742-48-9	Naphtha, VM&P (Petroleum Distillate)	44.8	0.92	41.2
8030-30-6	Naphtha (Petroleum Distillate)	44.8	0.92	41.2
8052-41-3	Naphtha (High Flash)	44.8	0.92	41.2
64742-95-6	Naphtha, VM&P (Petroleum Distillate)	44.8	0.92	41.2
64742-94-5	Naphtha, VM&P (Petroleum Distillate)	44.8	0.92	41.2
7727-37-9	Nitrogen	0.0	–	0.0
8002-74-2	Paraffin (Wax)	–	–	A(5)
109-66-0	Pentane	45.0	0.93	41.9
127-18-4	Perchloroethylene (Tetrachloroethylene)	–	–	A(5)
64741-65-7	Petroleum Distillate	44.8	0.92	41.2

CAS# (1)	Material Name	ΔH_C(2) (kJ/g)	X_{CH}(3)	ΔH_{CH}(4) (kJ/g)
147-14-8	Phthalocyanine Blue	–	–	A(5)
1328-53-6	Phthalocyanine Green	–	–	A(5)
51-03-6	Piperonyl Butoxide	37.2	0.86	32.0
9005-65-6	Polyoxyethylene Sorbitan Oleate	–	–	A(5)
9005-64-5	Polyoxyethylene (20)Sorbitan Monolaurate	–	–	A(5)
74-68-6	Propane	46.3	0.95	44.0
57-55-6	Propylene Glycol	21.4	0.96	20.5
78-92-2	sec-Butyl Alcohol	32.9	0.91	39.9
—	Silica (Crystalline)	0.0	–	0.0
7631-86-9	Silica, Amorphous Hydrated	0.0	–	0.0
63148-58-3	Silicone Oil	–	–	A(5)
63148-62-9	Silicone Oil	–	A(5)	
—	Solids, Non-contributory	–	–	A(5)
—	Solids, Noncombustible/Flammable	0.0	–	0.0
1338-39-2	Sorbitan Monolaurate	39.5	0.96	37.9
26266-57-9	Sorbitan Monopaimitate	39.5	0.96	37.9
25038-32-8	Styrene Butadiene Rubber	–	–	A(5)
16252-10-5	Tin Oxide	0.0	0.0	–
13463-67-7	Titanium Dioxide	0.0	–	0.0
108-88-3	Toluene	40.5	0.70	28.4
102-76-1	Triacetin	36.9	0.96	35.4
79-01-6	Trichloroethylene	–	–	A(5)
7732-18-5	Water	0.0	–	0.0
1330-20-7	Xylene	40.9	0.67	27.4
1314 13-2	Zinc Oxide	0.0	–	0.0

NOTE –

(1) CAS# – Chemical Abstract Service Registry Number (Website: http://www.cas.org)

(2) H_C – Total Heat of Combustion. Theoretical heat of complete combustion (net) determined from heat of formation or heat of combustion data assuming all products in the vapour phase.

(3) X_{CH} – Chemical Combustion Efficiency. Chemical combustion efficiency generally determined by correlations based on chemical structure.

(4) H_{CH} – Chemical Heat of Combustion = $X_{CH}H_C$. Estimate of the amount of heat released under actual fire conditions in a normal atmosphere.

(5) Materials with closed cup flash points greater than 260 °C.

K2 PREREQUISITES TO THE SPRINKLER SYSTEM DESIGN CRITERIA

The sprinkler design requirements for the protection of aerosols storage (see 907.7), are applicable subject to aspects of building construction and management as detailed in this Appendix.

K2.1 Mercantile locations (i.e. supermarkets, department and discount stores)

The sprinkler design requirements of 907.7 apply only to mercantile locations where packaged aerosols are stored in small, fire-resistant cut-off rooms, with self-closing doors, and a FRR not less than -/60/60.

K2.2 Palletised and solid pile aerosols storage

The sprinkler design requirements of 907.7 apply only to palletised and solid pile aerosols storage within buildings in which:

(a) Storage heights do not exceed one pallet load or 1.5 m;

(b) Level 2 Aerosols are stored without lateral constraint, with each group limited to 25 pallet loads, and spaced not less than 1.5 m clear of other groups and other storage;

(c) Level 3 Aerosols are stored in fire-resistant cut-off rooms with self-closing doors and a FRR not less than -/60/60 in the case of storage of not more than six pallets outside of the warehouse, (e.g. shipping and receiving areas) with sprinkler protection in accordance with the hydraulic design requirements of table 9.24;

(d) The roof or ceiling height does not exceed 7.6 m for Level 2 Aerosols, or 6.1 m for Level 3 Aerosols. A suspended ceiling is installed where necessary to meet these requirements.

NOTE – Suspended ceilings should be of substantial construction, capable of withstanding temperatures above 538 °C for up to 10 minutes, and uplift velocity pressures of at least 0.14 kPa.

K2.3 Rack storage of level 2 aerosols

The sprinkler design requirements of 907.7 apply only to rack storage of Level 2 Aerosols within buildings in which:

(a) Pallet loads do not exceed 1.5 m in height in each rack tier;

(b) Sufficient vertical height of each rack tier exists to ensure that at least 150 mm clearance is maintained between in-rack sprinkler deflectors and the top of storage immediately below;

(c) Level 2 Aerosol storage is restricted to a dedicated area. In-rack sprinklers are provided in every tier of every rack located within that dedicated area. To control rocketing cans or burning debris, the dedicated area is defined by one, or a combination of, the following three alternative methods:

> *Method 1:* The dedicated area is defined by interior or exterior walls or chain link fences. Fencing is not lighter in construction than 3.1 mm diameter steel wire woven into a 50 mm diamond mesh. Where doorless openings exist, baffles are provided sufficient to prevent rocketing cans escaping to outside the dedicated area.
>
> *Method 2:* The dedicated area is defined by metal vertical barriers located at the ends of racks and at the back of single-row racks, in the longitudinal flue of double-row racks, or in the transverse flues of multiple-row racks, as depicted in figures K2(a) and K2(b). The barriers extend to the top of the storage.
>
> *Method 3:* The dedicated area is defined by extending the provision of in-rack sprinklers into adjacent storage, as depicted in figure K2(c);

(d) The storage height for Level 2 Aerosols does not exceed 7.5 m, except in automated rack storage warehouses;

(e) The rack storage is automated (where storage heights in excess of 7.5 m are acceptable):

   (i) Storage is confined to single-row and double-row racks with in-rack sprinklers fitted at each rack tier level

   (ii) Storage is confined within six-sided cages constructed from not less than 6 mm diameter steel rod formed into a mesh, with rods at centres not exceeding 53 mm in each direction. The cages are provided as attachments to racks or to pallets

   (iii) Control systems are provided which allow aerosols only in tiers protected with in-rack sprinklers. This provision is not capable of defeat by the warehouse operator. If an acceptable bay is not available, the aerosols are held in an adequately protected dispatch or receiving area until one is open

   (iv) Single-row racks and double-row rack aisles are at least 1.2 m wide. Aisles less than 1.2 m wide are treated as multiple-row racks

   (v) Storage in multiple-row racks does not exceed 7.5 m in height, and is protected with face sprinklers and in-rack sprinklers, (see figures 9.31(a) and (b))

   (vi) The requirements of figure K2(a) and item (v) above, also apply;

(f) Horizontal barriers are installed over the top tier of storage, with in-rack sprinklers fitted thereunder, wherever the clearance from the top of storage to the roof/ceiling is greater than 4.6 m. The barriers are of sufficient height to ensure that at least 150 mm clearance is maintained between in-rack sprinkler deflectors and the top of storage immediately below;

(g) Unconstrained Level 2 Aerosol storage is restricted to small quantities of up to six pallets or pallets within picking areas, located near the floor of the first rack tier, with in-rack sprinklers provided specifically for that one level and the level above. The underside of the first tier is maintained clear of storage and debris.

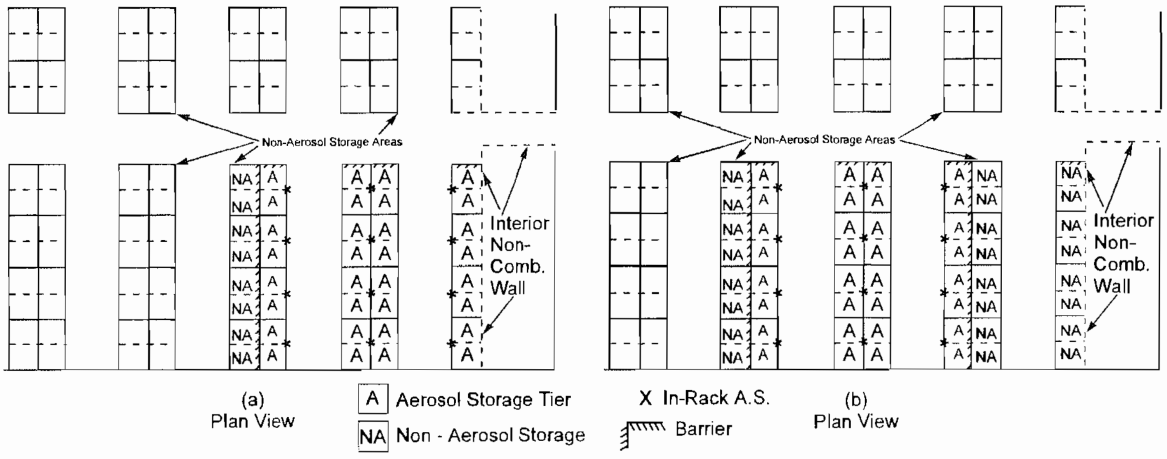


Figure K2(a) – Arrangement of barriers around dedicated Level 2 storage areas. Examples of storage areas defined by building walls and barriers in racks near walls

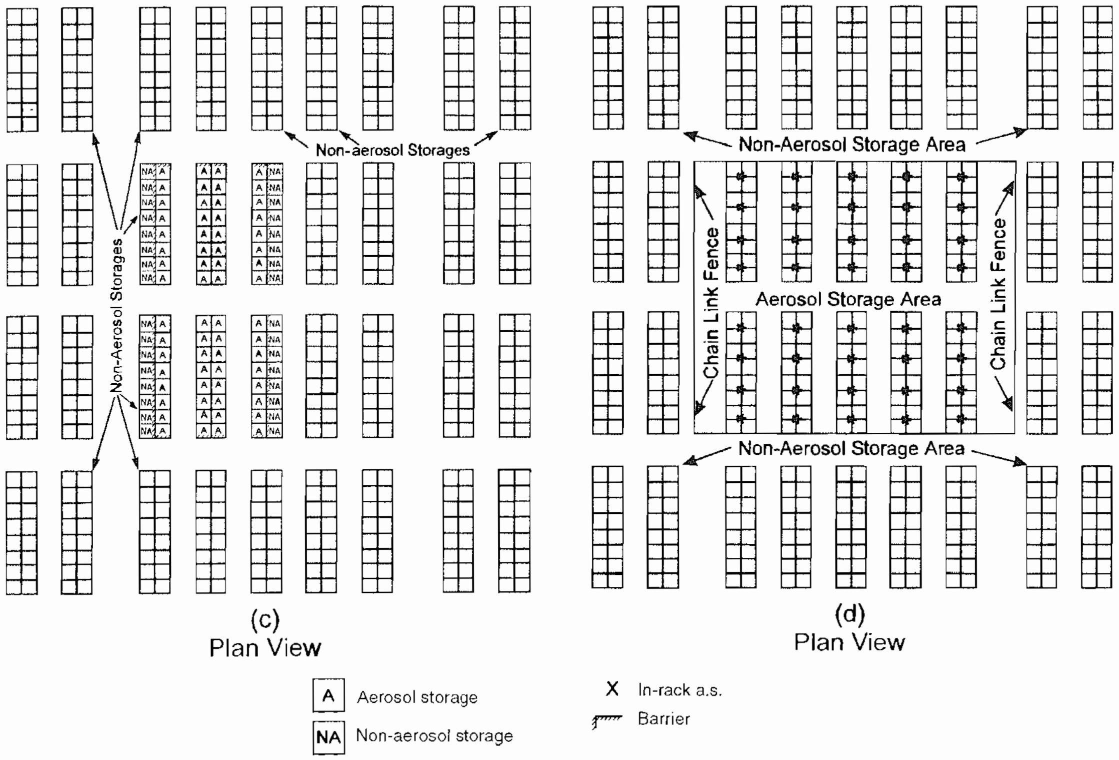
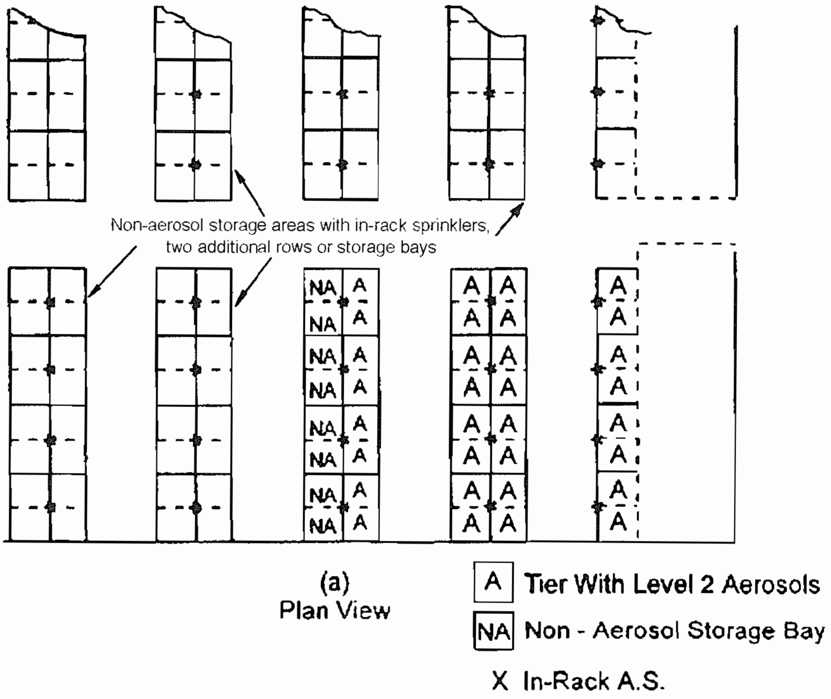
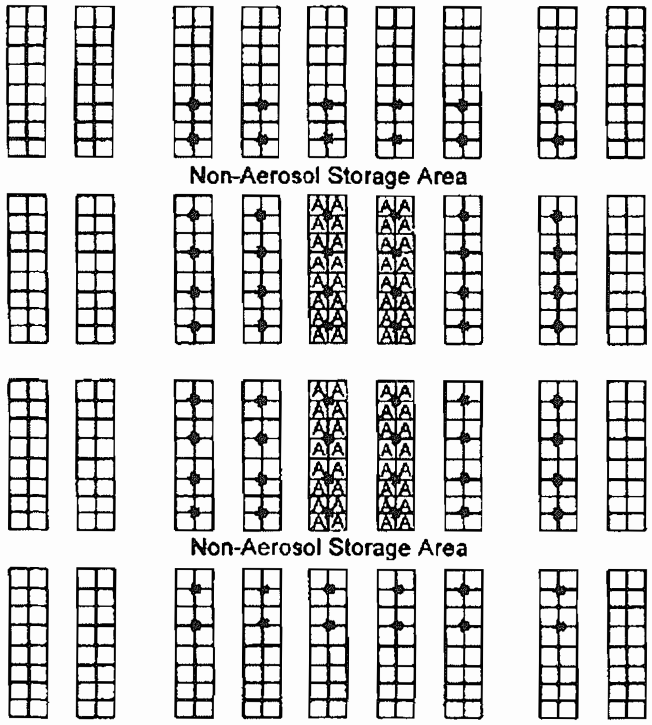


Figure K2(b) – Arrangement of barriers around dedicated Level 2 storage areas. Examples of storage area defined by barriers of fences away from walls (Method 1 and 2)


Non-aerosol storage areas with in-rack sprinklers, two additional rows or storage bays
NA
A
A Tier With Level 2 Aerosols
NA Non - Aerosol Storage Bay
X In-Rack A.S.

(a)
Plan View



(b)
Plan View

(a) Example of an area near building walls
(b) Example of area in the middle of building,
defined walls and barriers in racks

Figure K2(c) – Provisions for additional in-rack sprinklers around dedicated Level 2 aerosol storage area

K2.4 Rack storage of level 3 aerosols

The sprinkler design requirements of 907.7 apply only to rack storage of Level 3 Aerosols within buildings in which:

(a) Pallet loads do not exceed 1.5 m in height in each rack tier;

(b) The vertical height of each rack tier is sufficient to ensure that at least 150 mm clearance is maintained between in-rack sprinkler deflectors and the top of the storage immediately below;

(c) Level 3 Aerosol storage is restricted to a dedicated area. In-rack sprinklers are provided in every tier of every rack located within that dedicated area. To control rocketing cans or burning debris, the dedicated area is defined by one, or a combination of, the following two alternative methods:

Method 1: (The recommended method, where storage height is unrestricted). The dedicated area is defined by ceiling high interior or exterior walls having a FRR not less than -/60/60.

Method 2: A dedicated area is defined by ceiling high fencing, as follows:

(i) Fencing is not lighter in construction than 3.8 mm diameter steel wire woven into a 50 mm diamond mesh. Any doorless openings are provided with baffles sufficient to prevent rocketing cans escaping to outside the dedicated area

(ii) The dedicated area is used solely for rack storage

(iii) Storage height does not exceed 6.1 m

(iv) The fence is located at least 2.4 m clear of other storage outside the dedicated area, unless storage adjacent to the fence, outside the dedicated area, is no more hazardous than a Category 3 Commodity, and is in a rack configuration protected in accordance with the design criteria required for Level 3 Aerosols

(v) The design criteria for roof/ceiling level protection, as described in 907.7, is extended 6.1 m beyond the fence;

(d) Aisles between racks are at least 2.4 m wide;

(e) Multiple-row racks are not used;

(f) Horizontal barriers are installed over the top tier of storage, with in-rack sprinklers fitted thereunder, wherever the clearance from the top of storage to the roof/ceiling is greater than 4.6 m. The barriers are of sufficient height to ensure that at least 150 mm clearance is maintained between in-rack sprinkler deflectors and the top of storage immediately below;

(g) Heating is provided where there is likelihood of freezing;

NOTE – Pre-action systems or dry systems are not suitable for protection of Level 3 Aerosols.

(h) In picking areas, the following conditions apply:

(i) Level 3 Aerosol storage in single-row and double-row racks, is located near the floor in the first rack tier, with a horizontal barrier provided above the storage in the first rack tier

(ii) In double-row racks, aerosol storage is restricted to the side of the rack facing the picking area. A chain link fence, or similar constraint, is provided in the longitudinal flue, and at the ends, of the first rack tier of double-row racks

(iii) In single-row racks, a chain link fence, or similar constraint, is provided along the side of the rack opposite to the picking area, and at the ends, of the first rack tier

(iv) In flow-through racks (those with shelves consisting of slanted rollers spaced less than 300 mm apart so that product loaded on one side rolls to the other), aerosol storage is limited to the bottom 1.8 m of the rack. Vertical barriers are provided across the rack at 3 m intervals, to limit horizontal fire spread.

APPENDIX L – AEROSOL WARNING SIGNS

(Normative)

L1

Where aerosol warning signs are required, they shall conform to the following requirements.

L2

Generally:

Size	300 mm wide, 50 mm high (150 x 200 for Type B)
Materials	Metal
Securing	Screwed, bolted or pop rivetted
Location	As prescribed, at approximately 1.7 m above floor level and in a position that will be readily visible and unlikely to be obscured
Colour	White background; red lettering and black lettering
Lettering	Size 1 – readable from 5 m Size 2 – readable from 2 m Size 3 – readable from 1 m

NOTE – Lettering complying with Appendix A of NZS 5807 and having heights (h) of 8 mm, 5 mm and 3 mm is readable from 5 m, 2 m, and 1 m respectively.

L3

Type A

Purpose	To indicate that an area or rack is suited for the storage of Level 2 or 3 (as specified) Aerosols	
Features	Aerosol graphic in circle	Size 1
	“Aerosols”	Size 1
	“of Level (2 only/3) can be stored here”	Size 2
	Representative list	Size 3

L4

Type B

Purpose	To indicate that a particular container is suited for aerosol storage	
Features	Aerosol graphic in circle	Size 2
	“Aerosols”	Size 2
	“can be stored in this container”	Size 3

L5

Type C

Purpose	To indicate that the area is suited only for storage of aerosols of a specified level to a limited height	
Features	Aerosol graphic in circle	Size 1
	“Storage height limits”	Size 1
	“For Level (2/3) aerosols is ... m (... pallets high)”	Size 2
	Aerosol graphic in slashed circle	Size 2
	“Level 3 aerosol storage prohibited”	Size 2
	Representative list	Size 3

L6

Type D

Purpose	To indicate that storage of aerosols of Level 2 or 3 is prohibited in the rack or area.	
Features	Aerosol graphic in slashed circle	Size 1
	“Aerosols storage”	Size 1
	“Of Level 2 or 3”	Size 2
	“Prohibited”	Size 1

L7

The aerosol graphic should comply as far as practicable with the requirements of NZS 5807 (see figure L1).

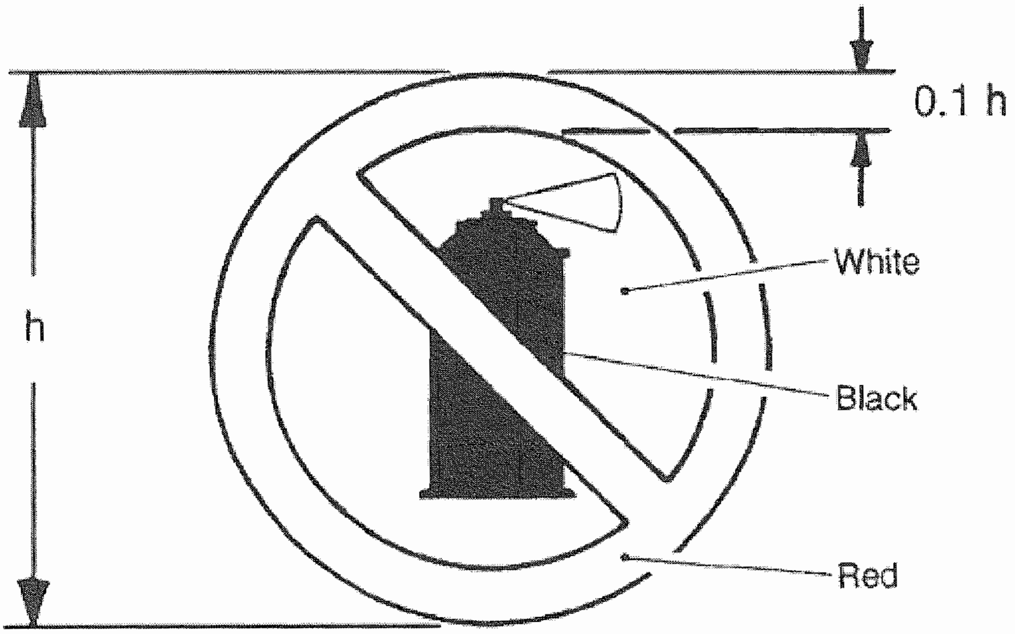


Figure L1 – Example of a graphic symbol to accompany warning signs prohibiting the storage of aerosols

APPENDIX M – CONTRACTOR'S MATERIAL AND TEST CERTIFICATE FOR UNDERGROUND PIPING

(Informative)

Contractor's Material and Test Certificate for Underground Piping

---

Procedure: Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners and contractor. It is understood the owner's representatives signature in no way prejudices any claim against the contractor for faulty material, poor workmanship or failure to comply with approving authority's requirements or local ordinances.

Property I.D.

Property Name:	Date:
Property Location:	

Plans:

Accepted By Approving Authority's Name(s)
Address:
Installation Conforms to Plans ☐ Yes ☐ No Equipment Used is Approved (If no, state deviations): ☐ Yes ☐ No

Instructions:

Has person in charge of fire equipment been instructed as to the location of control valves and the care and maintenance of this new equipment? If no, explain:	☐ Yes ☐ No
Have copies of appropriate instructions and care and maintenance charts been left on premises? If no, explain:	☐ Yes ☐ No

Location:

Supplies Buildings:

Underground Pipes and Joints

Pipe Types & Class:	Type of Joint:
Pipe Conforms to	Standard. ☐ Yes ☐ No
Fittings Conform to If No, Explain:	Standard. ☐ Yes ☐ No
Joints needing anchorage clamped, strapped, or blocked in accordance with standard. ☐ Yes ☐ No If no, explain:	

Test Description:

Flushing: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than 1500 L/min for 100 NB inch pipe, 3300 L/min for 150 inch NB pipe, 5900 L/min for 200 NB inch pipe, 9200 Lmin for 250 NB pipe.

Hydrostatic: Hydrostatic tests shall be made at not less than 1400 kPa for two hours or 340 kPa above static pressure in excess of 1000 kPa for two hours.

Leakage: New pipe laid with rubber gasketed joints shall, if the workmanship is satisfactory, have little or no leakage at the joints. The amount of leakage at the joints shall not exceed 2 L/h per 100 joints irrespective of pipe diameter. The leakage shall be distributed over all the joints if such leakage occurs at a few joints, the installation shall be considered unsatisfactory and necessary repairs made. The amount of allowable leakage specified above may be increased by 30 mL/25mm/h valve diameter per hour for each metal seated valve isolating the test section.

Continued

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Contractor's Material and Test Certificate for Underground Piping (continued)

Flushing Tests:

New Underground Piping flushed according to ....Standard. By: company. If no, explain:			☐ Yes	☐ No
How was flushing obtained? Through what type of opening?	☐ Public Water ☐ Hydrant Outlet.	☐ Tank or Reservoir ☐ Open Pipe	☐ Fire Pump	
Lead-ins flushed according to Standard By: company. If no, explain:			☐ Yes	☐ No
How was flushing obtained? Through what type of opening?	☐ Public Water ☐ Open Pipe	☐ Tank or Reservoir ☐ Hose Conn. To Flange or Spigot	☐ Fire Pump	

Hydrostatic Testing:

Equipment operates properly? ☐ Yes ☐ No	If no, reason:
Drain Test Reading of gauge located near water supply test pipe:	
Residual pressure with valve in test pipe wide open? ....kPa	
All new underground piping hydrostatically tested at ....kPa for ....hrs.	Joints Covered? ☐ Yes ☐ No

Leakage Test:

Total amount of leakage measured: Litres.	Hrs.
Allowable leakage: Litres.	Hrs.

Hydrants (if applicable)**:**

Number Installed:	Type and Make:
All operate satisfactorily? ☐ Yes ☐ No	

Control Valves:

Water Control Valves Left Wide Open? ☐ Yes ☐ No

If no, state reason:

Hose couplings of Fire Service connections and hydrants interchangeable with those of Fire Service answering alarm?
☐ Yes ☐ No

Remarks:

Signatures:

Name of Installing Contractor:

For Property Owner (Signed): Title: Date:

For Installing Contractor (Signed): Title Date:

Additional Explanation and Notes:

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APPENDIX N WATER MIST FIRE PROTECTION

(Informative)

N1 INTRODUCTION

Clause 304 of this Standard allows the use of water mist systems where they are listed. This Appendix backgrounds water mist systems and how they are used in fire protection. The volume of research and new product development over recent years makes the drafting of a complete and concise set of rules under which stand-alone water mist systems may be incorporated into NZS 4541 impracticable. This Appendix has been written to allow the user to judge whether specific water mist systems can be used under the auspices of NZS 4541. The user of the Standard is alerted to ANSI/NFPA 750 Standard on *Water mist fire protection systems* and Australian Standard AS 4587, *Water mist fire protection systems – System design, installation and commissioning*, for background information. These Standards may provide alternative approaches for use of water mist, where they are not deemed suitable as part of an NZS 4541 system.

N1.1 Water as a fire suppression agent

All fuels burn when they are in a gaseous state. Heat, generally at temperatures greater than 100 °C, is required to turn most solid and liquid fuels into vapour to allow them to burn. The latent heat of vaporisation of water at 100 °C makes it the most effective medium known for cooling most fuels and the atmosphere surrounding them to below vaporisation, and thus combustion, temperatures.

The usual method of automatically applying water to areas of combustion to cool and thus extinguish fires is covered by this fire sprinkler Standard.

Sprinklers distribute relatively large droplets of water in their clear space over their area of cover and from there the droplets fall to hit and splash onto the combustibles wetting the exposed surfaces to cool them below their combustion temperature. The drops, being large and well spaced are not efficient in cooling and scrubbing the heated convected products of combustion. Sprinklers tend to be the most widely used and most proven method of automatic fire suppression.

Water spray systems are specifically designed to generally project smaller droplets of water directly at burning fuels or over heated surfaces to efficiently wet and cool them.

Water mist systems apply very fine droplets to areas of combustion and the surrounding atmosphere to achieve rapid cooling using minimal water. Generally, the finer the water droplets are, the effectiveness of the water increases. However, small droplets cannot be easily projected over distance into the combustion zone because of their small mass, so misting systems require very specific design. Water mist systems generally extinguish very hot fires more effectively than small fires.

N1.2 Water mist operating mechanism

The mechanism by which water mist acts can be a complex combination of the following factors:

(a) Heat extraction as water is converted to vapour;

(b) Reduced oxygen levels as the water vapour displaces oxygen near the fuel;

(c) Direct wetting and cooling of combustibles;

(d) Enveloping of the protected area with water mist to block the transfer of radiant heat;

(e) Dilution of flammable vapours by the entrainment of water vapour, to such an extent that the resultant mixture will not burn;

(f) Chemical inhibition of forward combustion reaction by high water vapour levels; or

(g) Scrubbing soluble corrosive products of combustion from smoke.

N2 DEVELOPMENT OF WATER MIST

Two recent events have created market forces, which have driven the development of water mist systems.

The Scandinavian Star fire tragedy of April 7, 1990, in which 158 people died on a non-sprinklered vessel, led the International Maritime Organisation (IMO) to amend the Safety of Life at Sea (SOLAS) regulations, to require all ships carrying more than 36 passengers in international transport, and entering service after 1 October 1994, to be protected by an automatic sprinkler system, or its equivalent. This, and with the requirement to retro-fit existing ships by the year 2005, led to research to develop systems of lower weight and water flow requirements.

The second driving force has been the phasing out of halons under the Montreal Protocol, which has been the impetus in regard for alternatives to halons, for both land-based and marine applications.

N3 DEFINITION

ANSI/NFPA 750 defines water mist as being, "a water spray for which the D_V 0.99, as measured at the coarsest part of the spray in a plan 3.3 ft (1 m) from the nozzle, at its minimum design pressure, is less than 1000 microns".

Effectively, water mist can be described as water spray, with the droplets being finer than traditional sprinkler or nozzle sprays. The total potential heat absorption is a function of the heat absorption surface area. As for a sphere, the surface area is a function of the diameter squared, for a given mass of water the potential heat absorption rate quadruples if the droplet diameter halves.

However, small droplet size alone is not the only measure of potential effectiveness. For some situations the ability of water to penetrate the fire plume or to pre-wet fuel may also be important and this requires that the water droplets be large enough to have adequate momentum. This illustrates some fundamental points about water mist. It is complex in its operating mechanism, and conventional knowledge gained about 'normal' sprinkler systems does not necessarily apply.

The three most important characteristics of water mist are droplet size distribution, flux density and spray momentum. The relationships among these three characteristics and the extinguishing effectiveness of a spray are complex. For a given droplet size distribution, successful extinguishment may be achieved with high flux densities and low momentum, or with low flux densities and high momentum.

N4 WATER MIST PERFORMANCE OBJECTIVES

The performance objectives for which water mist systems have been found to be effective include:

(a) Extinguishment, where the fire is intended to be suppressed, with no further burning of combustibles;

(b) Fire suppression, where the rate of heat release is expected to be sharply reduced, to the point where regrowth would not occur;

(c) Control, where fire growth is limited by pre-wetting combustibles in the vicinity of the fire;

(d) Exposure protection, where combustibles near the fire are wetted to delay their ignition; and

(e) Temperature control, where room temperatures are reduced during combustion, to allow safe egress and reduce damage.

In practice, more than one of these objectives may be required for adequate performance of the system. Given that the temperature control objective is not one that would be commonly expected by users of a sprinkler Standard, it is expected that if this is the sole design objective required, that the system may be designed and installed in accordance with ANSI/NFPA 750 or AS 4587. Note that 303.3 discusses use of waterspray systems for cooling (i.e. temperature control) and controlled burning.

N5 WATER MIST APPLICATIONS

Water mist systems have been developed, tested and marketed for a diverse range of risks and applications. This includes equivalency to automatic sprinkler systems to cater for risks up to and equivalent to ordinary hazard group 3 occupancies, flammable liquid storage areas, and machinery spaces. Specific applications are being developed for specialised risks, such as gas powered turbines.

In reviewing any system for listing, it is expected that a Sprinkler System Certifier would review the results of the full-scale fire tests carried out, and the basis of any third party listing requirement.

N6 BASIS FOR REVIEWING WATER MIST LISTINGS

N6.1 Introduction

A Sprinkler System Certifier is expected to list water mist systems on the basis of the criteria specified in this section of this Appendix.

Listed systems or components are only those included in a list published by an internationally recognised fire protection and listing authority such as:

(a) Underwriters Laboratories (UL);

(b) Loss Prevention Council (LPC);

(c) Factory Mutual Global (FM Global);

(d) Scientific Services Laboratories (SSL);

(e) Verband der Sachversicherer (VdS); and

(f) Marine Classification Societies.

The results of the listing investigation should identify, but not be limited to the following:

(g) The maximum and minimum system flow rates, i.e. the flow rate per unit volume or the unit flow rate per unit area as applicable to the specific risk;

(h) The maximum and minimum nozzle operating range;

(i) Nozzle performance ranges covering spray angle, droplet size and distribution, momentum and velocity;

(j) Nozzle installation requirements giving the maximum and minimum distances above the floor of the hazard and below the ceiling. Nozzle spacing, orientation, minimum distance from the walls and obstructions and shielding;

(k) Any limitations on system floor areas, ventilation requirements and allowable enclosure openings.

(l) The listing criteria should be based on the results of full-scale fire testing, representative of the risk.

N6.2 Nozzles

Water mist is broken into the following three general types by ANSI/NFPA 750:

(a) Low pressure (up to 12.1 bar pressure);

(b) Intermediate pressure (up to 34.5 bar pressure);

(c) High pressure (over 34.5 bar pressure).

It is not expected that high-pressure nozzle-based systems would be deemed to be as reliable as a conventional sprinkler system, and as such, could not be listed to comply with this Standard. Such systems could be installed to an alternative Standard, such as AS 4587 or ANSI/NFPA 750.

Water mist nozzles are classified by ANSI/NFPA 750 as being:

(d) Automatic;

(e) Non-automatic; and

(f) Hybrid.

Hybrid nozzles can be either automatic or non-automatic, or both, and contain an in-built detection/activation device that can be operated by an independent activation device.

Due to potential inherent complexity with hybrid nozzles, it is expected that such systems would not be deemed to be as reliable as a sprinkler system. If they were to be used, they could be designed in accordance with ANSI/NFPA 750 or AS 4587.

Automatic nozzles, if their operating mechanisms are shown to have similar reliability to automatic sprinkler systems, could be installed in accordance with their listing criteria. Such operating elements would be expected to utilise sprinkler bulb or fusible element based operating mechanisms.

Open nozzles are to be installed as either deluge, or tail-end deluge systems, in accordance with 303. Such systems are to be controlled by a system of 15 mm pilot heads. This requirement does not preclude an alternative control arrangement; for example, a system using a smoke detection system, if installed in parallel with the pilot operated heads.

Water mist nozzles are also classified by the method by which the mist is generated.

(g) Diffuser impingement (a jet of water hitting a diffuser – similar to the method that conventional sprinkler spray is generated). Typically, this would include Grinnell's AquaMist nozzle.

(h) Pressure jet uses a number of relatively small orifices discharging high velocity streams of water, usually through some kind of swirl action. A typical, well-known nozzle using this principle is Marrioff's High-fog nozzle.

(i) Gas atomizing nozzles generate water mist by combining compressed gas with water in a mixing chamber upstream of the nozzle orifice. Manufacturers using this principle include Securiplex. As such, systems would have a higher level of complexity than would normally be expected of a sprinkler system, they should be installed in accordance with ANSI/NFPA 750 or AS 4587.

(j) Impinging jet nozzles are those where pairs of fine fluid jets strike each other at acute angles to form a mist. Kidde in the UK are developing a range of water mist nozzles using this principle.

It is not expected that gas atomizing nozzles would be deemed to be as reliable as an automatic sprinkler, and as such, it is not expected that such systems could be approved under the auspices of NZS 4541.

N6.3 Water supplies

Water supplies shall comply with the provisions of Part 6 of this Standard. On presentation of suitable documentation to substantiate a water supply duration, a Sprinkler System Certifier may list a water mist system with a water supply duration and volumes less than that specified by 606.1.1.

N6.4 Hydraulic calculations

Hydraulic calculations may be performed using the Hazen-Williams calculation method for all low pressure water mist systems. Hydraulic calculations may be performed using the Hazen-Williams calculation method for intermediate and high pressure systems having a minimum 20 mm pipe size, provided that the maximum flow velocity through the system piping does not exceed 7.6 m/s.

N6.5 Pipework and fittings

Pipework and fitting selection shall reflect the requirements of maximum system working pressures. This may require the use of pipework specifications exceeding those of pipework listed in Part 4 of this Standard. Pipework shall be of a suitable corrosion resistant material, as required by the system listing. Galvanised pipe is not deemed to provide adequate corrosion resistance for this service, unless specifically detailed in the listing.

N6.6 Strainer

A main waterway strainer shall be installed upstream of the nozzles, in a position conducive to maintenance. The strainer mesh shall be selected so that no dimension is greater than 80 % of the smallest nozzle orifice.

APPENDIX O – EMBANKMENT SUPPORTED MEMBRANE PILLOW TANKS

(Normative)

O1 GENERAL

O1.1

This Appendix specifies the minimum criteria for the materials, embankment preparation, and installation, of embankment supported membrane pillow tanks for fire protection water storage purposes.

O2 PERFORMANCE

The membrane tank manufacturer shall provide evidence of a 20-year minimum life when installed in accordance with the requirements of this specification, and the physical properties of the finished membrane tank assembly shall comply with the following requirements:

Property		**Test Method**	**Value**
Weight		ASTM D751	70 g/m^2
Thickness		ASTM D751	1.0 mm
Breaking strength	Warp Fill	ASTM D751 Grab	1.334 kN 1.335 kN
Tear strength	Warp Fill	ASTM D2261 Tongue	90.0 N 90.0 N
Adhesion of coating to fabric: jaw separation speed 12 in. (305 mm)/min Puncture resistance – per MIL-T-6396E 4.6.17		ASTM D751	67.0 N/25 mm width minimum
Parallel to warp			400.0 N minimum
Parallel to fill			400.0 N minimum
45 degrees to cords			400.0 N minimum
Abrasion resistance Wheel – H-22 Weight – 100 g/wheel		ASTM D1183 Taber	No fabric showing after 4000 cycles
Blocking resistance		5872*	Rating of 1-maximum
Seam strength 51 mm (2 in.) wide specimen		8311**	No seam slippage
Low temperature Flexibility MIL-C-8068 B (ASG). 4.4.4.2			No cracking at –29 °C

* Federal Test Method Standard 191A

** Federal Test Method Standard 601-8311

O3 CONSTRUCTION

O3.1 Fabric

The fabric shall be watertight, UV resistant, abrasion and weather resistant, and with properties as specified in O2.

O3.2 Design

The tank design shall:

(a) Result in an assembly, which will have seams of strength equal to, or greater than, the strength of the basic tank construction;

(b) Accommodate the field attachment of inlet/outlet fittings during installation;

(c) Enable the tank to be tested for leakage prior to shipment.

The top surface of the tank shall be coated with weather resistant elastomeric paint.

O4 EARTHWORKS AND TANK INSTALLATION PROCEDURE

O4.1 Earthworks

The embankment and earth base which support the tank shall be of the typical form shown in figure O1, with a wall slope of 1.5 to 1, unless the certifying engineer rules the soil to be unsuitable for this slope.

O4.1.1

The design of the embankment facility shall be by a professional civil engineer who shall provide, where necessary, or required, a specification, drawings and a design certificate, to ensure the design requirements are properly carried out.

O4.1.2

The base level of the tank shall be determined by the requirements of the fire protection system and shall be nominated by the fire protection contractor or his authorised representative.

The embankment and earth base may be constructed on grade, or below ground level, dependent on pump requirements and local soil and groundwater conditions.

Embankments shall be built from suitable soil, formed, compacted and trimmed by a competent earthmoving contractor, under the supervision of the design engineer.

The inside corners of the embankment, at the intersection of the dyke walls, shall be rounded using a radius of 300 mm at the bottom, with uniform graduation to a radius of 750 mm at the top.

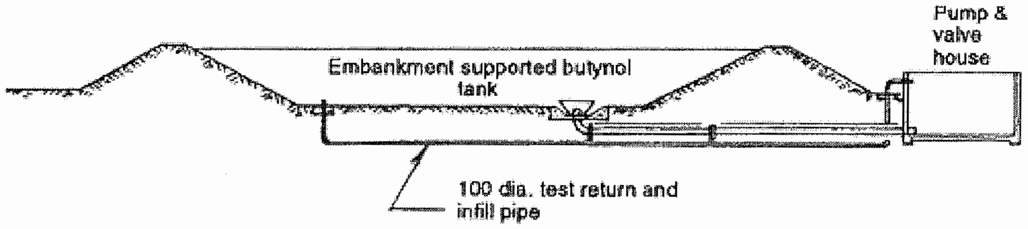
Where two tanks are installed with a single embankment between tanks, such embankment shall be designed to resist the load of a full single tank when one tank is drained.

O4.1.3

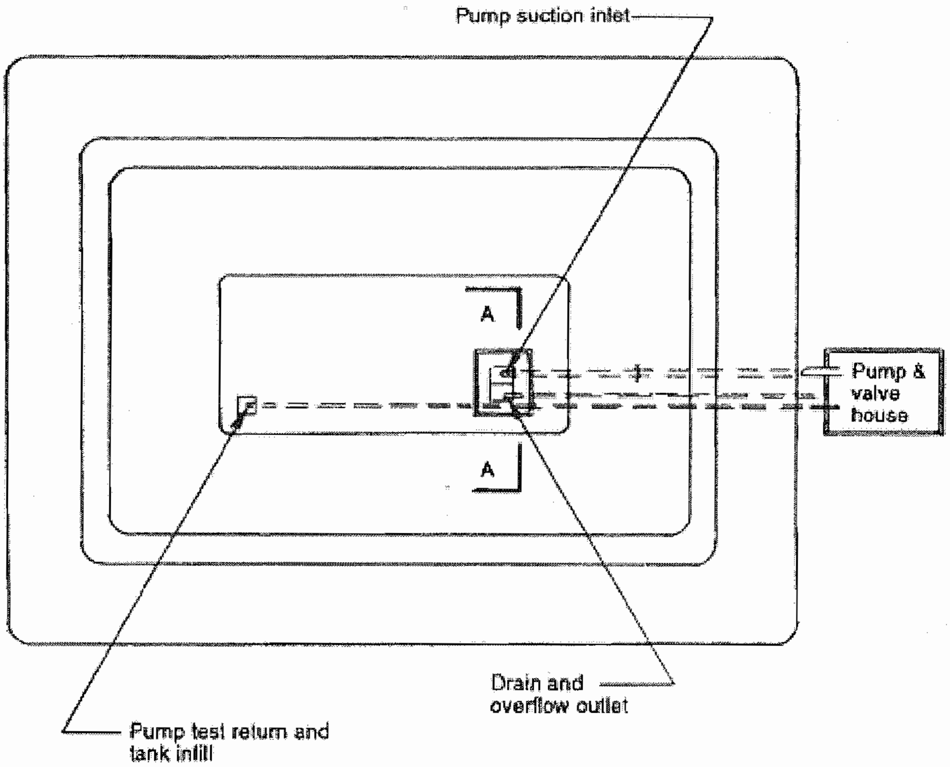
The floor of the tank shall be graded to locate the pump suction/drain fitting at a minimum of 75 mm below the inside toe of the embankment. Grading between this fitting location and all points along the toe of the embankment shall be uniform to provide positive drainage.

O4.1.4

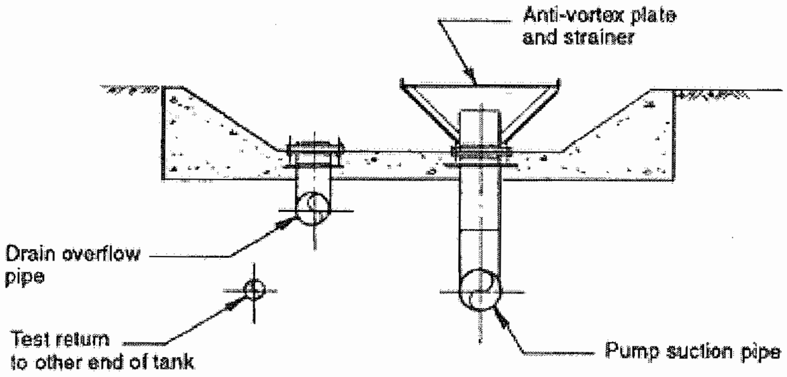
Construction tolerances for the earthworks shall be as determined by the design engineer.


Pump & valve house
Embankment supported butynol tank
100 dia. test return and infill pipe

CROSS SECTION (Scale 1:200)



PLAN (Scale 1:200)


Anti-vortex plate and strainer
Drain overflow pipe
Test return to other end of tank
Pump suction pipe

SECTION A-A (Scale 1:30)

Figure O1 – Typical details of embankment supported membrane pillow tank

O4.1.5

The finished surfaces of the inside embankment walls and the floor shall be free from all sharp rocks and debris, holes or other items which may damage the flexible membrane water tank.

O4.1.6

The design shall include suitable means for drainage of rainwater, away from the water tank in accordance with the design engineer's specification. These may include some of the following:

(a) A layer of selected pea-gravel below fine sand or soil binding layer on the floor;

(b) A porous drainpipe around the floor perimeter to convey rainwater from beneath the tank through the embankment to a free discharge point or sump pump;

(c) Porous pipes running down the length of the inside slopes at intervals to drain rainwater off the tank top down into the toe drains around the floor perimeter.

O4.1.7

The exterior sides and top of dyke walls should be stabilised against soil erosion by sowing grass or by other suitable means.

O4.2 Installation

O4.2.1

The tank manufacturer or his authorised representative shall accomplish installation of the tank in the prepared embankment.

The tank connection fittings shall be installed on site. The fire protection contractor shall supply tank connection pipes and fittings to the tank contractor for installation.

O4.2.2

Tank testing, filling and setting the overflow level shall be carried out under the direction of the tank manufacturer or his authorised representative.

O5 TANK SUMP AND SUPPORT FOR BOTTOM FITTINGS

O5.1 Pump suction/drain

The concrete pad which contains the pump suction fitting and common drain/overflow fitting of the tank shall be located with the centre line of the pump suction fitting a minimum of 2 m from the toe of the embankment walls.

O6 PIPE CONNECTIONS AND FITTINGS

O6.1 General

The tank fittings, accessories and piping connections shall be as shown in figure O1. The fittings attached to the tank are to be flanged. All steel parts shall be galvanised.

O6.2 Fittings attached to tank

O6.2.1

The tank shall include one or more manholes with a buoyant cover plate to which is attached an air vent.

O6.2.2

The tank shall be fitted with securing straps at the time of manufacture. During the installation and filling, these straps are to be secured to anchorage points provided on the embankment walls to ensure the tank rests uniformly against the embankment on all four sides. The tank shall be tested for leakage after installation. The entire operation shall be carried out under the direction of the tank manufacturer's field representative.

O6.2.3

The fittings located in the tank bottom shall include a pump suction/drain fitting with integral overflow and a separate pump test return/infill fitting located diagonally opposite in the tank base. The fittings shall be located and secured to concrete sumps in the bottom of the tank. A connection to the overflow line may be made for the tank level sensing and for automatic infilling.

O6.2.4

An approved anti-vortex plate assembly similar to that shown in figure O1 shall be bolted to the pump suction fitting.

APPENDIX P – MAINTENANCE PROVISIONS FOR NON-STANDARD SPRINKLER SYSTEMS

(Informative)

P1 INTRODUCTION

Part 12 of this Standard details maintenance provisions for standard wet pipe sprinkler systems. This Appendix provides guidelines for the preparation of maintenance regimes for non-standard sprinkler systems, (or parts thereof), including, but not limited to dry pipe systems, preaction systems, mist systems, antifreeze systems and the like. Clause 1202.7 states that a Sprinkler System Certifier may specify such other tests as may be necessary for non-standard types of systems. In practice, it is expected that a Sprinkler System Certifier will request that the contractor prepare a maintenance testing and inspection regime, for review and approval. Given the potential variety of types of non-standard systems, it is not practical to include comprehensive guidelines within this document.

This Appendix has been prepared to provide some guidance on the preparation of such a regime.

P2 GENERAL GUIDELINES

In preparation of maintenance guidelines, it is recommended that reference be made to internationally recognised fire protection maintenance standards. Examples of Standards that could be used as a guideline include:

(a) ANSI/NFPA 25 *Inspection, testing, and maintenance of water-based fire protection systems.*

(b) AS 1851 *Maintenance of fire protection systems and equipment.*

In addition, reference should be made to the manufacturer's data sheet for the listed hardware used in non-standard sprinkler systems.

NOTE – One of the requirements in Listing Fire Protection hardware, such as deluge valves, pre-action valves and the like, is that the manufacturer publishes a data sheet on the product, which details installation and maintenance instructions necessary to ensure reliable service.

It should be noted that when using these documents as a base to prepare a maintenance regime, the longer-term preventative maintenance intervals differ between these standards, and New Zealand practices. That is, where New Zealand specifies "valve overhauls" and the like on a four-yearly cycle, Australia uses a 3-yearly cycle, and America uses a five-yearly cycle. To ensure consistency with other provisions within this Standard, it is recommended that a four yearly cycle be used for non-standard systems.

P3 MINIMUM REQUIREMENTS

The minimum requirements for a maintenance schedule shall include the following:

(a) Quarterly

  (i) All valve stations should be inspected for obstructions and for obvious defects and faults

  (ii) All subsidiary stop valves should be inspected to ensure that they are locked and strapped in their normal operating position, and that the valve supervisory device functions correctly

  (iii) Any alarm functions, such as low air or nitrogen pressures, rise in pressure alarms switches and the like, should function and indicate correctly

  - (iv) An inspection should be carried out of any ancillary plant, such as air dryers, compressors and the like, to ensure that they are functioning correctly;

(b) Annually

  - (i) A full flow trip test should be carried out of any dry pipe valves, preaction valves, and deluge valves and the like
  - (ii) Antifreeze systems shall be drained, their solution concentration shall be tested, and the system recharged

    NOTE – This does not imply that fresh solution is required. The purpose of draining the system is to ensure that the solution is agitated, and thoroughly mixed when refilled.
  - (iii) Check valves shall be exercised and checked for correct function
  - (iv) Premix foam solutions should be replaced
  - (v) Foam concentrate samples should be drawn from any storage tanks and evaluated in a Listed Laboratory
  - (vi) A comprehensive survey should be carried out of any control systems, in accordance with their installation code
  - (vii) For fire alarm control type systems, this could include an annual survey in accordance with NZS 4512;

(c) Biennially

  - (i) Systems should be comprehensively inspected against the original design and Standard in force at the time of installation to ensure that they are in sound condition, have not deteriorated and are fit for purpose;

(d) Quadrennially

  - (i) All control valves should be overhauled, with all elastomeric elements replaced

    NOTE – Replacement elastomeric elements should be sourced from the equipment manufacturer. Unless otherwise endorsed in the equipment manufacturer's data sheet, replacement elastomeric elements should not be cut from sheet rubber and the like.
  - (ii) Foam systems proportioning systems should be tested for correct proportioning ratios;

(e) Ten yearly

  - (i) Foam bladder tanks should be hydrostatically tested.

P4 SPECIAL PROVISIONS FOR ANTIFREEZE FILLED SYSTEMS

Clause 1202.4(b) requires that the strength of antifreeze solutions be tested at least annually. To ensure that the integrity of the sprinkler system is not compromised, it is essential that the tests be carried out on solution representative of that in the system.

It is recommended that annual tests be carried out by completely draining each section in to a catch tank, measuring the specific gravity of the solution, ascertaining the percentage of antifreeze solution, adjusting it if necessary and refilling the installation.

This procedure should be repeated for each section of the installation, subdivided by check valves and/or subsidiary stop valves.

Measurement of antifreeze solution specific gravity needs to be related to antifreeze solution temperature to allow the antifreeze solution concentration to be ascertained. ANSI/NFPA 13 section 7.5 provides useful graphs to allow common antifreeze agent concentrations to be estimated, as a function of specific gravity and solution temperature.

APPENDIX Q – GUIDANCE ON THE TESTING OF SPRINKLERS

(Informative)

Q1 BACKGROUND

Clause 1205 of this Standard requires that sprinklers undergo routine testing to ensure that their expected levels of reliability are maintained. This appendix provides guidance on tests and why such tests should be undertaken.

It has been argued that such testing is not necessary, as problems will be identified via tests carried out in other countries. There have been a number of international replacement programmes that have included sprinklers that required replacing within New Zealand. However, these international replacement programmes do not address site-specific conditions that may impact on sprinkler reliability. Such conditions include, but are not limited to, corrosion, paint or paint spray loadings, pipe scale forming in sprinkler orifices and the like. With respect to dry sprinklers, testing carried out by Underwriters Laboratories has indicated that the harsh environment that these heads are usually installed in means that these heads should be replaced every 10 years – or if used on a large scale, tested to ensure that they will provide reliable service.

Q2 RECOGNISED TESTING LABORATORIES

This Standard requires that the heads be tested by a “recognised” testing laboratory. At the time of preparation of this Standard, the committee drafting this clause was not aware of any laboratory providing sprinkler-testing services within New Zealand. Sprinkler testing facilities are available from at least two laboratories in Australia, and from Underwriters' Laboratories in USA.

The term “recognised' implies a level of competence – while noting that it is unlikely that overseas laboratories would seek Listing to operate within New Zealand's small market.

Q3 SAMPLES

Samples taken from a building should be representative of the occupancy of the building. For example, in a high-rise office or apartment building, with an underground car park, samples should be taken from both the occupied areas of the building and the car park area. It is imperative that environmentally dissimilar areas are considered when selecting samples, especially if harsh environmental areas are present.

In the situation where a small number of dry sprinklers are used within a large building – for example, the freezers in a supermarket – it may be more cost effective to replace the sprinklers than to test them.

Q4 TEST REGIME

The samples should be subjected to a minimum of the following:

(a) A visual inspection;

(b) Release temperature testing, to ensure that they operate within tolerances specified in manufacturing standards;

(c) Leak resistance test to 1.5 times maximum working pressure (sprinkler manufacturing test pressures exceed this test pressure);

(d) Functional tests including seat release pressures;

(e) For Fast or Quick Response heads, a Response Time Index (RTI) Sensitivity test.

Q5 FAILURE OF SPRINKLER HEADS

Clause 1205.5 states that where one sample head fails to meet the test requirement, all heads represented by that sample should be replaced. Before replacing all heads, some order of subjectivity is required. For example, if a visual inspection indicates that the head has suffered mechanical damage, as witnessed by a bent deflector, then it would be reasonable to carry out a visual inspection of the other heads in the area, and only replace those also exhibiting mechanical damage. However, if testing indicates excessive seat release pressures, then all similar heads should be replaced.

Q6 REFERENCED DOCUMENTS

The following documents may be useful in finding out performance criteria when evaluating sprinkler tests results:

ISO 6182-1 *Fire protection – Automatic sprinkler systems – Part 1: Requirements and test methods for sprinklers*
ISO 6182-7 *Fire protection – Automatic sprinkler systems – Part 7: Requirements and test methods for early suppression fast response (ESFR) sprinklers* (now known as suppression mode sprinklers)
UL 199 *Standard for automatic sprinklers for fire-protection service*
UL 1626 *Residential sprinklers for fire-protection service*

APPENDIX R – EVALUATION OF CONTRACTORS BY A SPRINKLER SYSTEM CERTIFIER (SSC)

(Normative)

R1

This Standard is drafted on the basis that contractors undertaking, and having responsibility for, the roles allocated by the Standard have acquired a general understanding of fire sprinkler technology and possess sufficient experience, resources, competence and organisation to permit the informed application of the requirements of the Standard.

The requirement that contractors be listed by a SSC (see 113.2) is not intended to deny to any organisation the right to engage in contracts for fire sprinkler systems. Rather it is intended that before exercising such rights a contractor has and can demonstrate to a SSC appropriate experience, resources, competence and organisation.

R2

SSCs shall establish and define the specific criteria and standards of competence for listing and re-listing of contractors against the various scope elements of table R1. These criteria and standards of competence shall meet the intent of R1, and shall be included in a SSC's AS/NZS ISO/IEC 17020 schedule of accreditation. A SSC shall make its listing criteria and standards of competence available in the public domain.

NOTE – It would be expected that this documentation should be freely available on a SSC's website.

R3

The listing shall identify the activities and, for each activity, the associated system types in its scope (see table R1).

R4

Any request for listing or re-listing shall be initiated by an application from the contractor to a SSC and shall be subject to the approved assessment and certification programme applicable to the scope of listing being sought.

R5

A listed contractor shall comply with the criteria and standards of competence for listing at all times. To ensure ongoing compliance:

(a) A SSC may withdraw listing by providing 30 days written notice of a non-compliance with the listing criteria and standards of competence, to afford an opportunity to the contractor to remedy the non-compliance; and

(b) Listings shall expire as detailed on the listing certificate. (See Appendix S.)

R6

The scope of listing shall be the range of activities and types of system from table R1 on which a contractor has been deemed to be competent to undertake work by a SSC.

Table R1 – Scope of listing

Activity	System type							
	Residential	Conventional wet	Dry pipe	Control mode specific application	Suppression mode	Foam	Antifreeze	Deluge and preaction
Project management								
Design								
Supply								
Erection								
Fabrication								
Maintenance and testing								
Routine inspection								

APPENDIX S – CERTIFICATE OF LISTING OF CONTRACTOR

(Normative)

S1

See 113.3 for prescriptive requirements of certificates.

Certificate for use when all requirements are met.

CERTIFICATE OF LISTING OF CONTRACTOR
CERTIFICATE No. xxxx

On the basis of the information supplied in the Application for Listing as a fire sprinkler system contractor, this organisation, as the nominated Sprinkler System Certifier, considers that the requirements of 113 of NZS 4541:2007 have been adequately met for the purposes described in that Standard.

Registered Company Name: ....

Physical address:..

Scope of listing (in accordance with table R1 of NZS 4541: 2007): ....

Key personnel: As per the attached schedule to this certificate.

To have effect from:

This certificate shall expire on _____________ unless withdrawn earlier, after 30 days notice.

This certificate is PROVISIONAL ONLY, pending completion of an AS/NZS ISO 9000 accredited quality system in accordance with 113 of NZS 4541:2007. (delete if not applicable)

Signed.. Date ....

Name .... Designation...

SSC COMPANY NAME

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S2

Certificate for use when AS/NZS ISO 9000 accreditation is pending.

CERTIFICATE OF LISTING OF CONTRACTOR

This is to confirm that, on the basis of the information supplied in the Application for Listing as Contractor dated ...., this organisation, as the nominated Sprinkler System Certifier, considers that the requirements of 113 of NZS 4541:2007 have been adequately met for the purposes described in that Standard.

Certificate number .... to have effect from .... for 24 months
(Date)
unless withdrawn after 30 days notice.

Signed .... Name ....
(Print)

Sprinkler system certifier ....

PROVISIONAL ONLY until (date ....) pending completion of AS/NZS ISO 9000 accreditation of the quality system.

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APPENDIX T – GUIDELINES FOR EVALUATION OF EQUIPMENT FOR LISTING BY A SPRINKLER SYSTEM CERTIFIER (SSC)

(Normative)

T1

This Standard has been produced on the assumption that the equipment that is to be installed in sprinkler systems complying with this Standard should have a proven performance and reliability.

The requirement that equipment be listed, by a Sprinkler System Certifier (SSC) (see 114), is not intended to deny any organisation the right to sell equipment for installation in fire sprinkler systems. Rather it is intended that before exercising such rights the manufacturer/supplier can demonstrate to a SSC that the equipment is sufficiently reliable and suitable for the intended use.

The purpose of this Appendix is to provide guidance to both the applicant manufacturer/supplier and a SSC.

T2

Equipment shall have the necessary attributes at all times and not simply at the time of evaluation.

Accordingly it is envisaged that:

(a) The manufacturer/supplier who is seeking the right to have an item of equipment listed is prepared to carry stock replacement/spare parts at all times that the equipment is listed and will continue to supply replacement/spares while the equipment remains in service;

(b) Listing may be withdrawn at any time but 30 days notice of any shortcoming would be given by a SSC before withdrawing the listing, to afford the opportunity to the manufacturer/supplier to remedy the same.

T3

Any request for listing (or re-listing) shall be accompanied by a completed Application for Listing of Equipment form as shown in T4, which shall include the following information:

(a) Date from which listing is sought;

(b) Name of manufacturer;

(c) Name, postal address, phone and fax number of supplier;

(d) Name of manager/contact;

(e) Make and model;

(f) If the item is UL, FM or LPC listed/approved, then evidence of this listing/approval together with a manufacturer's information sheet describing the details of the approval is to be provided;

(g) Any special conditions which the manufacturer/supplier considers or requires to be applied in order for the equipment to perform in a reliable and adequate manner;

(h) Any other information requested by a SSC; and

(i) Describe how the product may be identified.

T4 APPLICATION FOR LISTING OF EQUIPMENT

APPLICATION FOR LISTING OF EQUIPMENT As per 114 of NZS 4541:2007	
Item	
For use as	
Manufacturer	
Supplier	
Address	Contact Phone no. Fax no.
Make	
Model	
Reference information	
Range limitations	
Restrictions and warnings	
Special conditions	
Signed	Date
Name	Designation

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T5

Evidence of listing shall be in the form of a Listing Certificate as shown in T6.

T6 LISTING CERTIFICATE – SPRINKLER SYSTEM EQUIPMENT

LISTING CERTIFICATE – SPRINKLER SYSTEM EQUIPMENT

As per 114 of NZS 4541:2007

This is to confirm that, on the basis of the information supplied in the application for listing of the equipment dated ...., this organisation, as the nominated Sprinkler System Certifier, considers that the appropriate requirements of NZS 4541:2007 have been adequately met with respect to the item described below, for use under the conditions set out on this certificate.

Item

For use as

Certificate number	Effective from

Manufacturer/supplier

Make

Model

Reference information

Range limitations

Restrictions and warnings

Special conditions

Signed	Date
Name	Designation

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APPENDIX U – SPRINKLER SYSTEM CERTIFICATE OF COMPLIANCE

(Normative)

SPRINKLER SYSTEM
CERTIFICATE OF COMPLIANCE

An inspection of the as-built plans and hydraulic calculations and a physical inspection on .... (date) of the sprinkler system installed at:

....

....

....

(name of building and full street address)

confirmed that this system conforms with the requirements of NZS 4541:2007 in all respects.

Date ....

Certificate No. ....

Signed ....

To have effect from ....

Expires ....

NOTE –

(1) This certificate remains the property of the sprinkler system certifier and may be withdrawn if the system ceases to comply.

(2) Ongoing compliance with the Standard requires that the system is routinely tested and supervised.

(3) Any alteration or extension to the building, or changes in occupancy or storage practice may necessitate alterations to the system and resubmission for approval.

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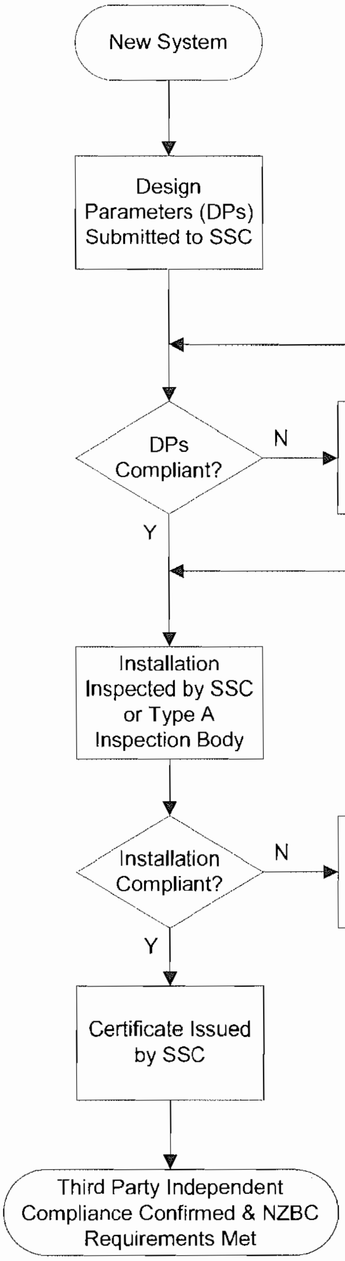
New System
Design Parameters (DPs) Submitted to SSC
DPs Compliant?
N
Design Parameters Amended
Y
Installation Inspected by SSC or Type A Inspection Body
Installation Compliant?
N
Non-Compliances Rectified
Y
Certificate Issued by SSC
Third Party Independent Compliance Confirmed & NZBC Requirements Met

Figure U1 – Compliance flowchart for new systems (see 112.4)

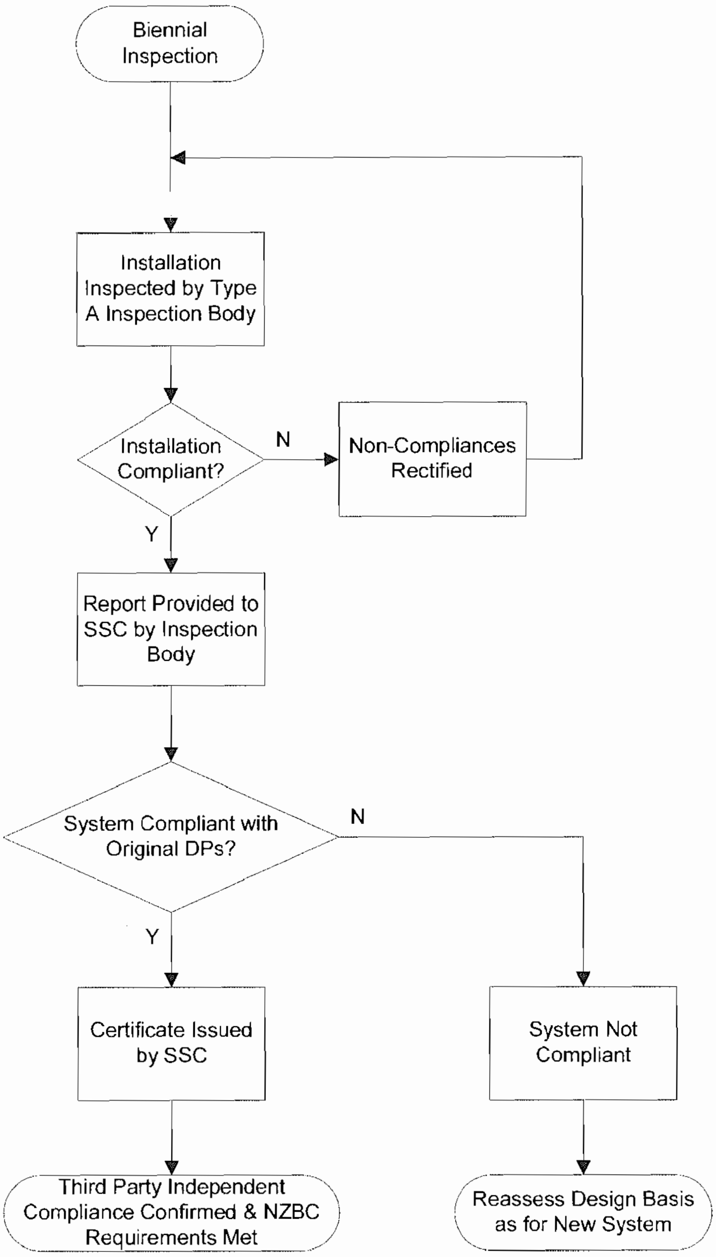
Biennial Inspection
Installation Inspected by Type A Inspection Body
Installation Compliant?
N
Non-Compliances Rectified
Y
Report Provided to SSC by Inspection Body
System Compliant with Original DPs?
N
Y
Certificate Issued by SSC
System Not Compliant
Third Party Independent Compliance Confirmed & NZBC Requirements Met
Reassess Design Basis as for New System

Figure U2 – Compliance flowchart for biennial inspections (see 1203.1)

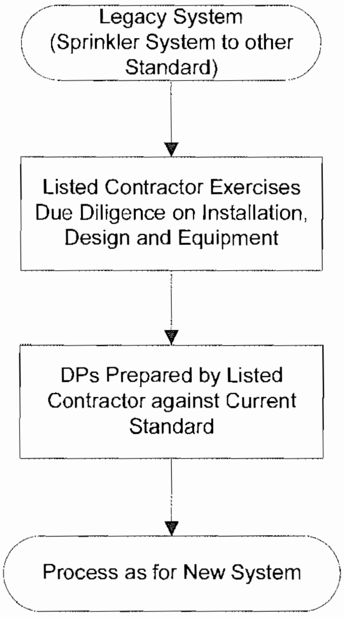
Legacy System (Sprinkler System to other Standard)
Listed Contractor Exercises Due Diligence on Installation, Design and Equipment
DPs Prepared by Listed Contractor against Current Standard
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Figure U3 – Compliance flowchart for systems installed to other Standards (see Appendix F)

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